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WIND EROSION PREDICTION

This section of the South Dakota Technical Guide (SDTG) explains the primary factors that influence erosion by wind and provides guidance on the use of the Wind Erosion Equation (WEQ). The wind erosion equation is an erosion prediction model designed to predict the long-term average annual soil loss from a defined area.

The National Agronomy Manual (NAM) contains the following two methods for estimating wind erosion: (1) the critical wind erosion period method and (2) the management period method. In South Dakota, both methods can be used to estimate wind erosion. This Technical Guide addresses the procedure and applicability of each method of wind erosion prediction.

1. Critical Period Method uses one calculation for each year of a rotation. The values for the corresponding WEQ factors describe the conditions encountered during the most erosive period in each year. The average annual erosion is the sum of estimated erosion for all years in the rotation divided by the number of years covered by the rotation. In situations where erosion conditions such as wind speed and ground cover change throughout the year, the management period method should be used.
2. Management Period Method is used when significant erosion is expected to occur in more than one erosion period. The different management periods are characterized by a substantial change in vegetative cover (V), ridge roughness (K), preponderance, or a change in the prevailing wind direction as it relates to unsheltered distance (L). Erosion estimates for each period are weighted according to the percentage of annual erosive wind energy that occurs during the period. Average annual erosion is the sum of estimated erosion for each management period identified during the cropping system divided by the number of years in the rotation. The identified management periods must account for all the time periods throughout each year included in the rotation.

Part 502 of the NAM is the reference for WEQ and provides additional guidance and detail on wind erosion processes, predictions, and control. Contact the state conservation agronomist if you need assistance in erosion estimates for conservation planning situations.

ESTIMATING SOIL LOSS RESULTING FROM WIND EROSION

THE WIND EROSION EQUATION (WEQ).

The WEQ is used to predict soil loss by wind erosion for both the critical and management period methods. The equation is expressed symbolically as follows:

$$\underline{E} = f(IKCLV)$$

where

- \underline{E} = the estimated average annual soil loss by wind erosion in tons per acre per year.
- f = an indication that the equation includes functional relationships that are not straight-line mathematical calculations.
- I = the soil erodibility index. It is the potential annual wind erosion for a given soil under a given set of field conditions. This factor is expressed as the average annual soil loss in tons per acre per year from a field area that is isolated, unsheltered, wide, bare, smooth, level, loose, and noncrusted, and at a location where the climatic factor is 100.
- K = the ridge roughness factor. It is a measure of the effect of ridges made by tillage and planting implements. It is expressed as a decimal from 0.5 to 1.0.
- C = the climatic factor. It characterizes climatic erosivity, specifically wind speed and surface soil moisture. The factor for any given locality is expressed as a percentage of the C factor for Garden City, Kansas, which has a value of 100. C factors in South Dakota range from 20 to 60.
- L = the unsheltered distance along the prevailing wind erosion direction across the field or area to be evaluated.
- V = the vegetative cover factor. It considers the kind, amount, and orientation of vegetation on the surface. Vegetative cover is expressed in Small Grain Equivalent lbs./acre.

CRITICAL WIND EROSION PERIOD METHOD

The critical wind erosion period is the time of year when the greatest amount of wind erosion can be expected to occur from a field under an identified management system. It is the period when vegetative cover, soil surface conditions, and expected erosive winds, result in the greatest potential for wind erosion.

I. DETERMINING FACTOR VALUES FOR THE CRITICAL WIND EROSION PERIOD

A. Soil Erodibility Factor (I)

For most Natural Resources Conservation Service (NRCS) uses, named soils are placed in wind erodibility groups (WEG) and an I value is assigned to the WEG. The WEG is included on NRCS soil interpretation records and other interpretive tables. If the soil is not known, Table 1 can be used to determine the WEG from the surface texture.

TABLE 1
WIND ERODIBILITY GROUPS (WEG)

WEG	Predominant Soil Texture	Dry Soil Aggregates >0.84mm Percent	Wind Erodibility Index (I) (T/Ac/Yr)
1	Coarse sand	1	310
	Sand	2	250
		3	220 ^{1/}
	Fine Sand	5	180
	Very fine sand	7	160
2	Loamy very fine sand, loamy fine sand, loamy sand, loamy coarse sand, or sapric organic soil materials	10	134
3	Very fine sandy loam, fine sandy loam, sandy loam, or coarse sandy loam	25	86
4	Clay, silty clay, noncalcareous clay loam, or silty clay loam with more than 35 percent clay	25	86
4L	Calcareous loam and silt loam, or calcareous clay loam and silty clay loam.	25	86
5	Noncalcareous loam and silt loam with less than 20 percent clay, or sandy clay loam, sandy clay, and hemic organic soil materials	40	56
6	Noncalcareous loam and silt loam with more than 20 percent clay, or noncalcareous clay loam with less than 35 percent clay.	45	48
7	Silt, noncalcareous silty clay loam with less than 35 percent clay, and fibric organic soil material	50	38
8	Soils not susceptible to wind erosion due to coarse surface fragments or wetness.	--	--

^{1/} The "I" values for WEG 1 vary from 160 for coarse sands to 310 for fine sands. An "I" of 220 is an average value.

Adjusting "I" Value on Knolls

Adjustments should be made to the Soil Erodibility Index (I) on windward facing knolls where the windward facing slope is less than 500 feet long and the increase in slope gradient from the adjacent upwind landscape is 3 percent or greater. Both slope length and slope gradient change are determined along the direction of the prevailing erosive wind. The remainder of the field downwind from a knoll may have increased erosion due to the knoll effect. No method has been developed to estimate the increased amount of erosion on that portion of the field.

Knoll Erodibility

Table 2 contains knoll erodibility adjustment factors for the Soil Erodibility Index I . The I value for the Wind Erodibility Group is multiplied by the factor shown. This adjustment expresses the average increase in erodibility along the knoll slope and applies only to the portions of the field and knoll facing the prevailing erosive wind.

TABLE 2
KNOLL ERODIBILITY ADJUSTMENT FACTOR FOR I

Slope Change in Prevailing Wind Erosion Direction	Knoll Adjustment to I ^{1/}
3	1.3
4	1.6
5	1.9
6	2.3
8	3.0
10	3.6
10 - 15*	2.0
15 - 20	1.4
20+	1.0

* Factors above 10 percent slope change based on NRCS judgement. No research data available.

1/ After the knoll adjustment has been made, use the nearest available value for I in Table 1.

B. Ridge Roughness Factor (K)

K is a measure of the effect of ridges made by tillage and planting implements in reducing wind erosion. Ridges absorb and deflect wind energy and trap moving soil particles. Use Table 3 to determine ridge roughness factor.

TABLE 3

Ridge Spacing (Inches)	RIDGE ROUGHNESS K FACTOR											
	Angle of Deviation ^{1/} = 0°											
	Ridge Height (Inches)											
	0	1	2	3	4	5	6	7	8	9	10	11
7	1.0	0.7	0.5	0.5	---	---	---	---	---	---	---	---
10	1.0	0.8	0.5	0.5	0.6	---	---	---	---	---	---	---
14	1.0	0.8	0.6	0.5	0.5	0.6	---	---	---	---	---	---
18	1.0	0.9	0.6	0.5	0.5	0.5	0.7	---	---	---	---	---
20	1.0	0.9	0.6	0.5	0.5	0.5	0.6	0.8	0.8	---	---	---
24	1.0	0.9	0.7	0.5	0.5	0.5	0.5	0.7	0.8	0.8	---	---
30	1.0	0.9	0.7	0.6	0.5	0.5	0.5	0.6	0.7	0.8	---	---
36	1.0	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.7	0.8	---
38	1.0	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.7	0.8	---
40	1.0	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.7	0.8	0.8

Ridge Spacing (Inches)	RIDGE ROUGHNESS K FACTOR											
	Angle of Deviation ^{1/} = 22.5°											
	Ridge Height (Inches)											
	0	1	2	3	4	5	6	7	8	9	10	11
7	1.0	0.7	0.5	0.5	---	---	---	---	---	---	---	---
10	1.0	0.8	0.6	0.5	0.5	---	---	---	---	---	---	---
14	1.0	0.8	0.6	0.5	0.5	0.6	---	---	---	---	---	---
18	1.0	0.9	0.6	0.5	0.5	0.5	0.6	---	---	---	---	---
20	1.0	0.9	0.7	0.5	0.5	0.5	0.6	0.7	0.8	---	---	---
24	1.0	0.9	0.7	0.6	0.5	0.5	0.5	0.6	0.8	0.8	---	---
30	1.0	0.9	0.7	0.6	0.5	0.5	0.5	0.5	0.7	0.8	---	---
36	1.0	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.7	0.8	---
38	1.0	1.0	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.8	---
40	1.0	1.0	0.8	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.7	0.8

- 1/ The angle between the prevailing wind erosion direction and a line perpendicular to ridge direction.

TABLE 3 (cont.)

Angle of Deviation^{1/} = 45°

Ridge Spacing (Inches)	Ridge Height (Inches)											
	0	1	2	3	4	5	6	7	8	9	10	11
7	1.0	0.8	0.5	0.5	---	---	---	---	---	---	---	---
10	1.0	0.8	0.6	0.5	0.5	---	---	---	---	---	---	---
14	1.0	0.9	0.6	0.5	0.5	0.5	---	---	---	---	---	---
18	1.0	0.9	0.7	0.6	0.5	0.5	0.5	---	---	---	---	---
20	1.0	0.9	0.7	0.6	0.5	0.5	0.5	0.6	0.7	---	---	---
24	1.0	0.9	0.8	0.6	0.5	0.5	0.5	0.5	0.6	0.8	---	---
30	1.0	1.0	0.8	0.6	0.5	0.5	0.5	0.5	0.5	0.6	---	---
36	1.0	1.0	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.6	0.6	---
38	1.0	1.0	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.6	---
40	1.0	1.0	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.7

Angle of Deviation^{1/} = 67.5°

Ridge Spacing (Inches)	Ridge Height (Inches)											
	0	1	2	3	4	5	6	7	8	9	10	11
7	1.0	0.9	0.6	0.5	---	---	---	---	---	---	---	---
10	1.0	0.9	0.7	0.6	0.5	---	---	---	---	---	---	---
14	1.0	0.9	0.8	0.6	0.6	0.5	---	---	---	---	---	---
18	1.0	1.0	0.8	0.7	0.6	0.5	0.5	---	---	---	---	---
20	1.0	1.0	0.8	0.7	0.6	0.5	0.5	0.5	0.5	---	---	---
24	1.0	1.0	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.5	---	---
30	1.0	1.0	0.9	0.8	0.6	0.6	0.5	0.5	0.5	0.5	---	---
36	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.5	---
38	1.0	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.5	---
40	1.0	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5

Angle of Deviation = 90°

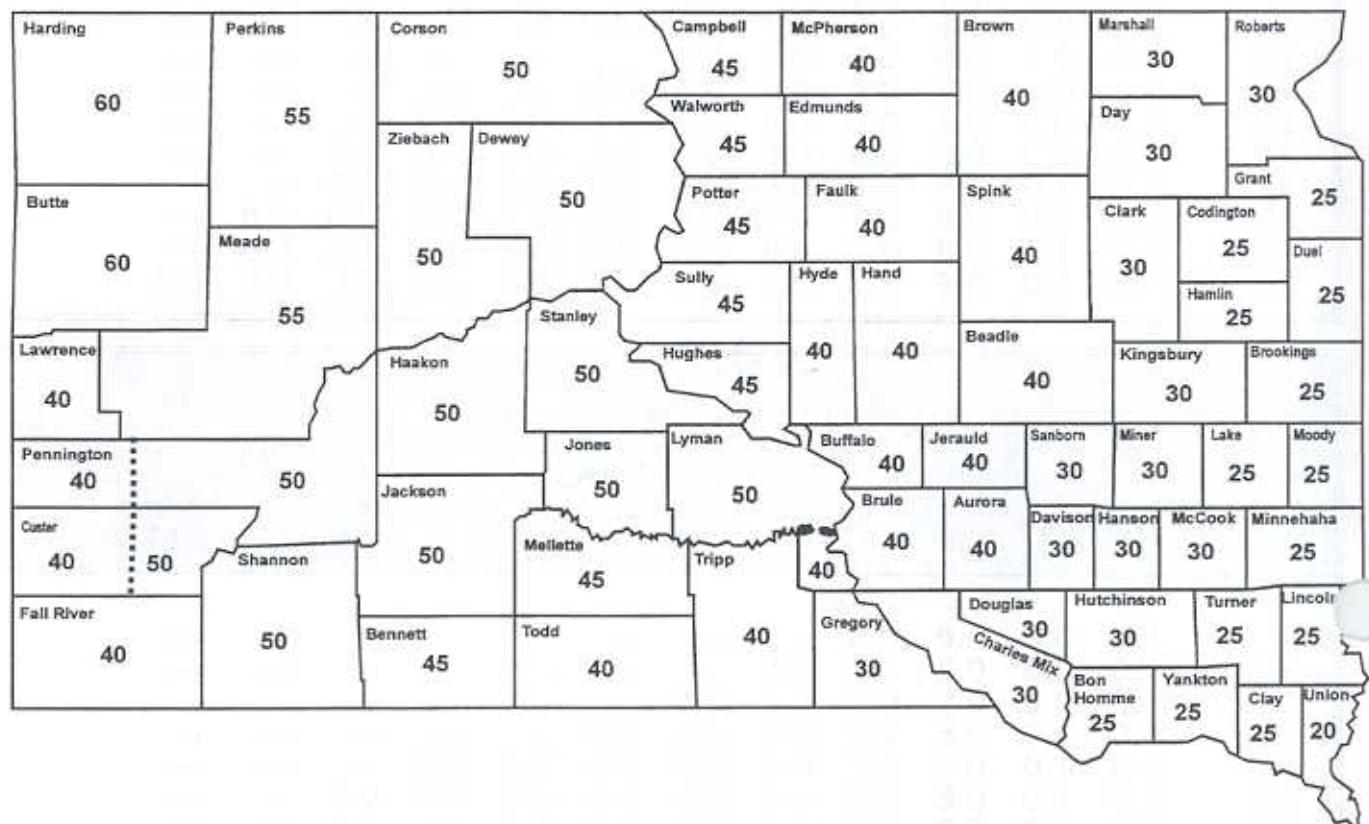
Soil Ridge Roughness, K Factor, is always 1.0 when prevailing wind direction is parallel to ridge pattern (angle of deviation = 90°).

- 1/ The angle between the prevailing wind erosion direction and a line perpendicular to ridge direction.

C. Climatic Factor (C)

The Climatic Factor is based on the average wind velocity and the precipitation-evaporation index for that location based on official weather records. Use annual "C" from Chart 1 for estimating annual soil loss.

CHART 1 "C" CLIMATIC FACTORS



D. Unsheltered Distance (L)

"L" represents the unsheltered distance along the prevailing wind erosion direction for the field or area to be evaluated. In the critical period method L can be measured directly on a map or calculated using a wind erosion direction factor.

The measured L is the unsheltered distance across an erodible area, measured along the prevailing wind erosion direction, beginning at a non-eroding boundary on the upwind side and continuing downwind to a non-eroding or stable area, or to the downwind edge of the area being evaluated. The annual prevailing wind erosion direction is shown in Chart 2.

To determine "L," using a wind erosion direction factor (WED), multiply the WED factor from Table 4, times the field width. "L" cannot exceed the longest possible measured distance across the field.

CHART 2 PREVAILING WIND EROSION DIRECTION AND DEVIATION
(To be used with the Critical Period Method only.)

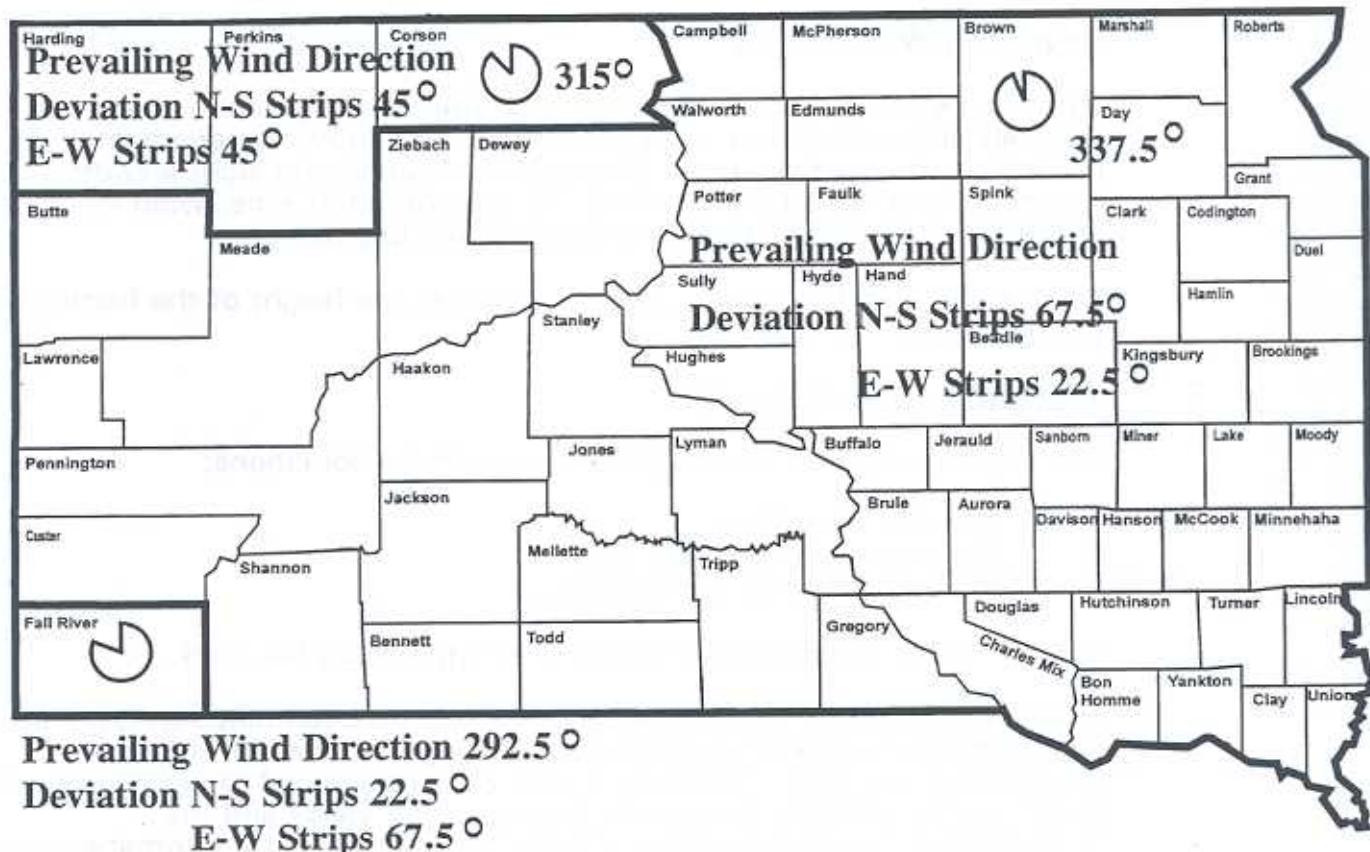


TABLE 4
WIND EROSION DIRECTION FACTOR

ANGLE OF DEVIATION ^{1/}	DIRECTION FACTOR
0°	1.0
22.5°	1.1
45.0°	1.4
67.5°	2.6
90.0°	L = Length of field

- 1/ The angle between the prevailing wind erosion direction and a line perpendicular to the long side of the field. The angle deviation for north-south or east-west fields are on Chart 2.

Vegetative Wind Barriers

Barriers are narrow strips of annual or permanent vegetation planted at intervals across fields for wind erosion control, snow management, or protection of sensitive crops. Barriers have sufficient height and density to create a sheltered zone downwind. In the protected zone, wind velocities are reduced enough to prevent saltation from beginning.

If there is a barrier present, subtract 10 times the height of the barrier from the calculated "L."

E. Vegetative Cover Factor (V)

The vegetative Cover Factor (V) combines three conditions:

1. The kind of residue;
2. The quantity of residue; and
3. The orientation of the residue.

The "V" value is expressed in small grain equivalent lbs./acre.

The value necessary for vegetative cover can be determined by estimating residue production and reduction for planning purposes or precisely measured in the field. Tables 5, 6, and 6A can be used to estimate residue quantities for planning purposes. Average crop yields and the corresponding residue value from Table 5 can be used to determine initial residue production at harvest. Estimations of residue reduction can be determined with Tables 6 and 6A.

The values in Table 6 were developed jointly by the NRCS, USDA, and the Equipment Manufacturers Institute, February 1992.

Each tillage or planting operation leaves a percent of the residue on the surface that was present just prior to that operation. The numbers in Table 6 represent the percentage remaining.

TABLE 5
RESIDUE PRODUCED BY CROP

Crop	Estimated Air Dry Residue Produced	
Barley	72	lbs./bu. grain
Buckwheat	1.5	lbs./lb. grain
Corn	56	lbs./bu. grain
Corn Silage Stubble	21	lbs. residue/ inch of stubble height/10,000 plants/acre
Dry Edible Beans	2.2	lbs./lb. grain
Field Peas (Dry)	1.2	lbs./lb. grain
Flax	80	lbs./bu. grain
Lentil	1.2	lbs./lb. grain
Millet	80	lbs./bu. grain
Oats	64	lbs./bu. grain
Potatoes.....	6	lbs./cwt.
Rape Seed	2	lbs./lb. grain
Rye.....	84	lbs./bu. grain
Rye (fall growth).....	175-500	lbs./ac.
Safflower	1.5	lbs./lb. grain
Sorghum (Grain)	56	lbs./bu. grain
<u>Plant population/ac</u>		
Sorghum silage stubble <58,000	32	lbs./inch/10,000 plants/acre ¹
>58,000	186	lbs./inch of stubble height ¹
Soybeans	75	lbs./bu. grain
Spring wheat	78	lbs./bu. grain
Sunflowers	2.2	lbs./lb. grain
Winter wheat	102	lbs./bu. grain
Winter wheat (fall growth)	175-260	lbs./ac.

Many factors affect the amount of residue left after a pass with a tractor and tillage or planting machine. Residue levels are sensitive to depth and speed of equipment operation and to row spacing. When selecting remaining residue values from Table 6 for a specific machine, consider the following general rules of thumb for a value from a range (i.e., 35-60). (1) At shallower operating depths greater amounts of residue are left on the surface, while at deeper operating depths more residue is buried. (2) Slower operating speeds tend to leave more residue on the surface, while at faster speeds more residue is buried. Under some conditions field cultivators and other finishing tools with field cultivator gangs and some planters and drills may return as much as 20 percent of the residue incorporated at shallow depths by recent previous operations. Excess wheel slippage caused by improper ballasting of tractor tires can destroy valuable residue in the wheel tracks. Higher retention values should be used when dealing with residue in excess of 2000 lbs. and the lower values when residue amounts are less than 2000 lbs.

Again, the values in Table 6 should only be used as a guide in conservation planning. Residue amounts left by each operation should be measured in the field to make necessary adjustments to table values.

Crop residue has been classified as being either Fragile or Nonfragile in Table 6A. This is a subjective classification based in part on the ease in which crop residues are decomposed by the elements or buried by tillage operations. Plant characteristics such as composition and size of leaves and stems; density of the residue; and relative quantities produced were considered. In addition, nonfragile residue may become fragile six months or more after harvest.

TABLE 6
RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining Nonfragile Percent	Fragile Percent
Drills		
Hoe opener drills.....	50-80	40-60
Semi-deep furrow drill or press drill (7"-12" spacing)	70-90	50-80
Deep furrow drill with >12" spacing	60-80	50-80
Single disk opener drills	85-100	75-85
Double disk opener drills (conventional)	80-100	60-80
No-till drills and drills with the following attachments <u>in standing stubble:</u>		
Smooth no-till coulters.....	85-95	70-85
Ripple or bubble coulters.....	80-85	65-85
Fluted coulters.....	75-80	60-80
No-till drills and drills with the following attachments <u>in flat residues:</u>		
Smooth no-till coulters.....	65-85	50-70
Ripple or bubble coulters.....	60-75	45-65
Fluted coulters.....	55-70	40-60
Air Seeders: Refer to appropriate field cultivator or chisel plow depending on the type of ground engaging device used.		
Air drills: Refer to corresponding type of drill opener.		
Row Planters		
Conventional planters with:		
Runner openers	85-95	80-90
Staggered double disk openers.....	90-95	85-95
Double disk openers	85-95	75-85
No-till planters with:		
Smooth coulters	85-95	75-90
Ripple coulters.....	75-90	70-85
Fluted coulters.....	65-85	55-80
Strip till planters with:		
2 or 3 Fluted coulters	60-80	50-75
Row cleaning devices	60-80	50-60
(8"-14" wide bare strip using brushes, spikes furrowing disks, or sweeps)		
Ridge till planter.....	40-60	20-40

TABLE 6
RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining	
	NonFragile Percent	Fragile Percent
Climatic Effects		
Over winter weathering:**		
Following summer harvest.....	70-90	65-85
Following fall harvest.....	80-95	70-80
Field Cultivators (Including leveling attachments)		
Used as the primary tillage operation:		
Sweeps 12"-20"	60-80	55-75
Sweeps or shovels 6"-12"	35-75	50-70
Duckfoot points	35-60	30-55
Field cultivators as secondary operation following chisel or disk:		
Sweeps 12"-20"	80-90	60-75
Sweeps or shovels 6"-12"	70-80	50-60
Duckfoot points	60-70	35-50
Finishing Tools		
Combination finishing tools with:		
Disks, shanks, and leveling attachments	50-70	30-50
Spring teeth and rolling basket	70-90	50-70
Harrows:		
Springtooth (coil tine)	60-80	50-70
Spike tooth	70-90	60-80
Flex-tine tooth	75-90	70-85
Roller harrow (cultipacker)	60-80	50-70
Packer roller	90-95	90-95
Rotary tiller:		
Secondary operation 3" deep	40-60	20-40
Primary operation 6" deep	15-35	5-15
Rodweeders		
Plain rotary rod	80-90	50-60
Rotary rod with semi-chisels or shovels	70-80	60-70
Strip Tillage Machines		
Rotary tiller, 12" tilled on 40" rows	60-75	50-60

** In northern climates with long periods of snow cover and frozen conditions, weathering may reduce residue levels only slightly; while in warmer climates, weathering losses may reduce residue levels significantly.

TABLE 6
RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining	
	Nonfragile Percent	Fragile Percent
Row Cultivators (30" and wider)		
Single sweep per row	75-90	55-70
Multiple sweeps per row	75-85	55-65
Finger wheel cultivator.....	65-75	50-60
Rolling disk cultivator.....	45-55	40-50
Ridge till cultivator	20-40	5-25
Unclassified Machines		
Anhydrous applicator.....	75-85	45-70
Anhydrous applicator with closing disks	60-75	30-50
Subsurface manure applicator	60-80	40-60
Rotary Hoe.....	85-90	80-90
Bedders, listers, & hippers.....	15-30	5-20
Furrow diker.....	85-95	75-85
Mulch treader	70-85	60-75
Plows		
Moldboard plow.....	0-10	0-5
Moldboard plow-uphill furrow (Pacific Northwest Region only).....	30-40	---
Disk plow	10-20	5-15
Machines which fracture soil		
Paratill/paraplow "V" ripper/subsoiler	80-90	75-85
12"-14" deep 20" spacing.....	70-90	60-80
Combination tools:		
Subsoil-chisel	50-70	40-50
Disk-subsoiler	30-50	10-20
Chisel Plows with		
Sweeps	70-85	50-60
Straight chisel spike points	40-80	30-60
Twisted points or shovels.....	35-70	20-40
Combination Chisel Plows Coulter chisel plows with:		
Sweeps	60-80	40-50
Straight chisel spike points	30-60	25-40
Twisted points or shovel	25-60	10-30
Disk chisel plows with:		
Sweeps	60-70	30-50
Straight chisel spike points	30-60	25-40
Twisted points or shovels.....	20-50	10-30

TABLE 6
RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement		Percent Residue Remaining Nonfragile Percent	Percent Residue Remaining Fragile Percent
<u>Undercutters</u> Stubble-mulch sweep or blade plows with:			
Sweep/"V"-blade >30" wide	75-95	60-80	
Sweeps 20"-30" wide.....	70-90	50-75	
<u>Disk Harrows</u>			
Offset			
Heavy plowing >10" spacing	25-50	10-25	
Primary cutting >9" spacing.....	30-60	20-40	
Finishing 7"-9" spacing	40-70	25-40	
Tandem			
Heavy plowing >10" spacing	25-50	10-25	
Primary cutting >9" spacing.....	30-60	20-40	
Finishing 7"-9" spacing	40-70	25-40	
Light tandem disk after harvest, before other tillage	70-80	40-50	
One-way disk with:			
12-16" blade	40-50	20-40	
18-30" blades.....	20-40	10-30	
Single gang disk.....	50-70	40-60	

TABLE 6A
RESIDUE TYPES

Nonfragile	Fragile
Alfalfa or legume hay	Canola/rapeseed
Barley*	Dry beans
Buckwheat	Dry peas
Corn	Fall seeded cover crops
Flaxseed	Lentils
Forage silage	Mustard
Grass hay	Potatoes
Millet	Safflower
Oats*	Soybeans
Pasture	Sugar Beets
Popcorn	Sunflowers
Rye*	Vegetables
Sorghum	
Speltz*	
Triticale*	
Wheat*	

* If a straw chopper is used during harvest or nonfragile straw is otherwise cut into small pieces during harvest, then after three months the residue should be considered fragile.

CHART 3 RELATIONSHIP OF RESIDUE WEIGHT TO PERCENT RESIDUE COVER

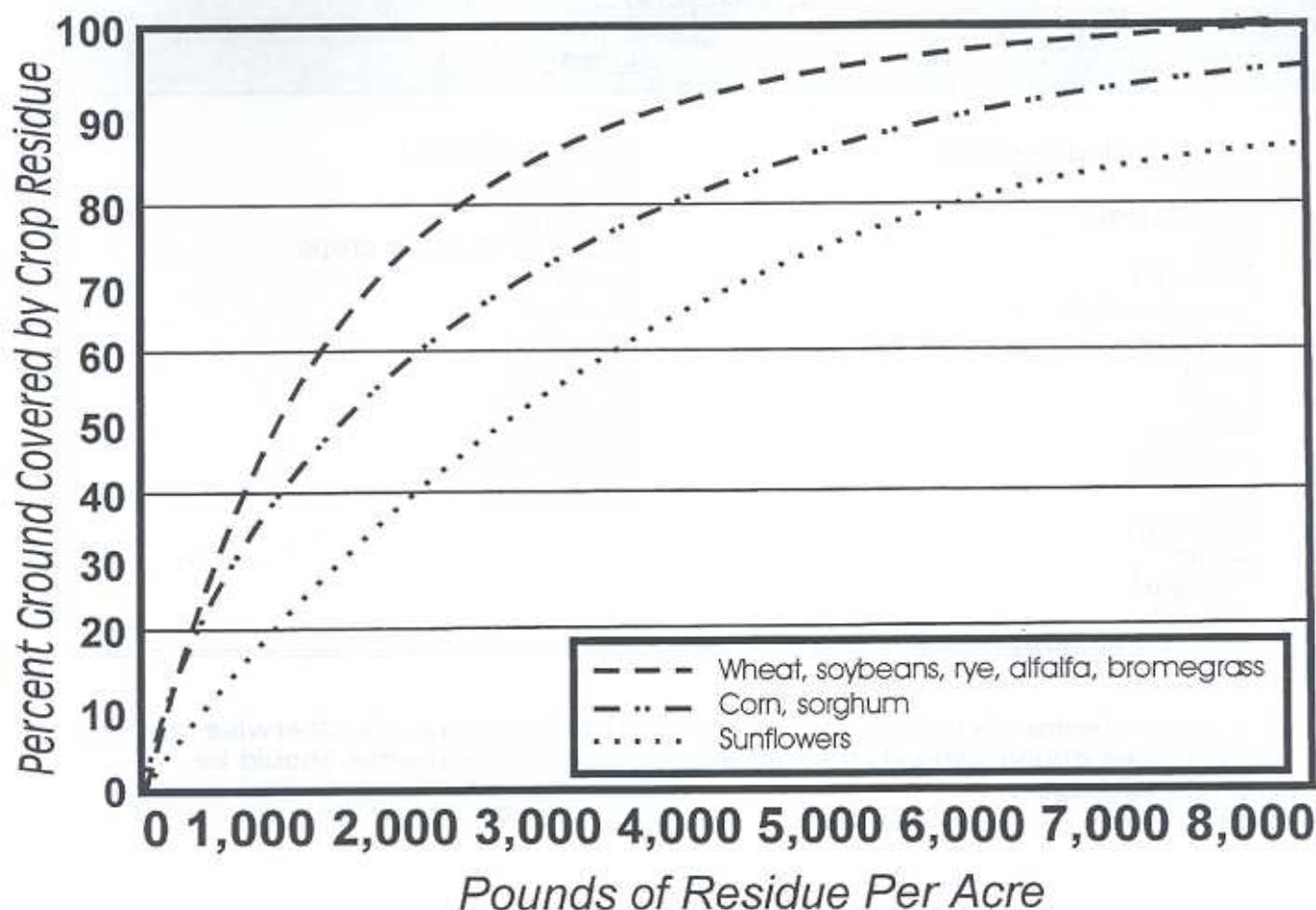


TABLE 7
RELATIONSHIP OF RESIDUE WEIGHT TO PERCENT RESIDUE COVER

	Alfalfa, Bromegrass, Rye	Wheat, Oats Soybeans	Corn	Sorghum	Sunflower
% Cover	-----lbs/ac-----				
5	95	85	135	145	215
10	190	180	275	295	440
15	295	275	430	450	675
20	405	380	585	620	930
25	525	490	755	800	1200
30	650	605	940	990	1485
35	785	730	1135	1195	1795
40	930	865	1345	1420	2130
45	1085	1015	1575	1660	2490
50	1260	1175	1825	1925	2890
55	1450	1355	2100	2220	3325
60	1665	1555	2410	2545	3820
65	1910	1780	2765	2915	4375
70	2190	2040	3170	3345	5015
75	2520	2350	3650	3850	5775
80	2925	2730	4235	4470	6705
85	3450	3215	4990	5270	7905
90	4185	3905	6060	6395	9595

Residue Estimation For Planning

The basic steps for estimating residue reduction are as follows:

1. Determine the total amount of residue produced using average crop yield and values provided in Table 5.
2. Convert the calculated pounds of residue from item 1 to percent residue cover using Chart 3 or Table 7.
3. Using Tables 6 and 6A determine the residue value for the period of interest in percent cover and then convert this value back to pounds of residue (Chart 3 or Table 7) in preparation for conversion to SGE.

Converting to Small Grain Equivalent (SGE)

SGE - The wind erosion control equivalent of vegetative cover, compared to a standard condition used for comparative testing in a wind tunnel. The standard (reference condition) is defined as small grain stalks 10 inches long lying flat on the soil surface in 10-inch rows which are perpendicular to the wind direction, with stalks oriented parallel to the wind direction. For comparison only, the reference condition is shown on each Chart 4 (Small Grain Equivalent Charts) as a dashed line. Crops with a line above and to the left of the reference condition line are more effective pound for pound at controlling wind erosion than small grain in reference condition. Crops with a line below and to the right of the reference condition line are less effective than small grain in the reference condition. The small grain equivalent value of field residues is a function of kind, amount, and orientation of growing plants or plant residues on the soil surface.

Note: Flat small grain in field condition (randomly distributed) must be converted to small grain equivalent.

After the residue reduction actions (Table 6) have been considered and the amount and orientation of air dry remaining crop residue has been determined, convert this value to flat small grain equivalent. Use the appropriate Chart 4 to make this conversion.

Estimating SGE of Mixed Vegetative Cover Consisting of Two or More Components.

Procedure:

1. Describe each major type of vegetative cover and estimate the percentage of total air-dry weight made up of each component.
2. Using the appropriate SGE Chart with the correct curve for each cover type, and using the TOTAL air-dry weight of all the vegetative cover on each chart, determine the SGE value of each component type.
3. Multiply the SGE value of each component (from step 2) by that component's percentage of total air-dry weight (from step 1).
4. Add the products (from step 3). The sum of the products is the weighted SGE for the mixed cover.

Example:

Crop: Winter wheat, 2,500 lb. residue (air-dry weight) after harvest. 1,500 lb. (60 percent) is standing stubble and 1,000 lb. (40 percent) is flat, randomly distributed straw.

Calculation:

Standing winter wheat:

$$2,500\text{lb.} = 8,500\text{lb. SGe} \times 0.60 = 5,100\text{lb.}$$

Flat winter wheat:

$$2,500\text{lb.} = 3,300\text{lb. SGe} \times 0.40 = 1,320\text{lb.}$$

Weighted Average SGe = 6,420lb.

Critical Period Erosion Summation

After I, K, C, L and V have been determined for the critical period in each year of the rotation, use the appropriate E Table located in Appendix A. The average annual erosion is the sum of the erosion in each year of the rotation divided by the number of years covered by the rotation.

MANAGEMENT PERIOD METHOD

The WEQ factors are selected that represent conditions during each identified crop management period. Dates are established for the beginning of the crop production year and the end of each crop management period. The percent of the erosive wind energy for each period is determined. The average annual soil loss is derived from the following:

1. Solve WEQ for E using management period values for I, K, L and V, and the annual value for C.
2. Estimate erosion for a period by multiplying the annual soil loss rate E, selected for the specific management period being evaluated, by the percentage of annual erosive wind energy which occurs during the period.
3. Estimate average annual erosion by adding the management period amounts for the crop year, or add the period amounts for a total crop sequence and divide by the number of years in the sequence.

The crop management period method is appropriate when:

- * WEQ factor values vary throughout the year.
- * Wind erosion estimates are needed for specific periods.
- * A system or practice is being designed to reduce crop damage during susceptible crop growth stages.

Crop tolerances to abrasion are usually less than soil loss tolerance. Estimated tolerances of several common and some specialty crops to wind erosion during the seedling stage are shown in Table 8. When crop damage is a major concern, the wind erosion control system should be designed to reduce wind erosion below the crop tolerance level (Table 8) from the seedling emergence to field stabilization. To estimate wind erosion during the seedling period, use the Management Period Method.

TABLE 8
ESTIMATED CROP TOLERANCES* TO BLOWING SOIL
*(From seedling emergence to field stabilization)

Tolerant - "T" 1/

Barley	Wheat
Buckwheat	Rye
Flax	Oats
Millet	Sorghum

Moderate Tolerance - 2 Tons/Acre/Year

Corn	Soybeans
Sunflowers	Sweet Corn
Cucumbers	

Low Tolerance - 1 Ton/Acre/Year

Alfalfa	Orchard Crops
Lima beans	Broccoli
Potatoes	Peas
Onions (> 15 days after emergence)	Snap Beans
Cabbage	Tomatoes

Very Low Tolerance - 0-0.5 Tons/Acre/Year

Spinach	Asparagus
Eggplant	Table beets
Sugar Beets	Squash
Carrots	Celery
Watermelons	Lettuce
Muskmelons	Onions (< 15 days after emergence)
Peppers	Strawberries

1/ Soil Loss Tolerance - use the WEQ management period method to determine erosion amounts. Use the WEQ management period method to determine erosion amounts. Crop Tolerance levels relate to the soil loss in tons/acre during the management periods from plant emergence to field stabilization. Crops may tolerate greater amounts of blowing soil than shown above but yield and quality will be adversely affected.

The basic steps for using the crop management period method are as follows:

1. Establish the crop management periods with a beginning date for the crop or crop sequence and ending dates for each management period. TABLE 9 lists an average planting date and the days after planting to reach 10, 50, and 75 percent canopy cover. Actual planting dates may be used in place of the date shown. The days required to reach each canopy value should not change. The crop production year(s) may be divided into as many management periods as is appropriate. A substantial change in V, K, preponderance, and prevailing wind direction as it relates to L may constitute the need to initiate a break in management periods. When the computer version of WEQ is fully operational, it is recommended that a management period be initiated at the beginning of each month where preponderance or prevailing wind direction changes.
2. Determine soil erodibility I as in making critical wind erosion period estimates. Adjustments of I for crusting can be made when using the management period method.

3. Determine the pattern of ridge roughness K for each crop management period from Table 3. The prevailing wind erosion direction may change with crop management period. Thus, a change in the angle of deviation may influence K along with changes in ridge height and spacing. See Table 10 to select an appropriate prevailing wind erosion direction for the location.
4. Select the appropriate climatic factor C from Chart 1. Use the annual C factor for determining all crop management period erosion rates.
5. Determine the unsheltered distance L for each crop management period. This is a calculated L using prevailing wind erosion direction, preponderance and field length to width ratios to find the "Wind Erosion Direction Factor."
 - A. Determine the appropriate prevailing wind erosion direction and preponderance from Table 10 for each management period at your location.
 - B. Measure the actual length and width of the area being evaluated and determine the ratio of length to width.
 - C. Determine the angle of deviation between the prevailing wind erosion direction and an imaginary line perpendicular to the long side of the field.
 - D. Using information obtained in "A" through "C" determine the erosion direction factor from Table 11.
 - E. Multiply the field width from "B" by the wind erosion direction factor from "D."
 - F. Calculate L using this method for each crop management period.
 - G. Credit wind barriers present by subtracting 10H from the calculated L.
6. Determine V by first estimating the kind, amount, and orientation of the residue and/or growing crop for each crop management period. Growing crop biomass information is provided in Table 12.
7. Convert the values recorded in step 6 to flat small grain equivalents (SGe) using Charts 4(1) - 4(29). When both the previous crops residue and a growing crop are present use the following procedure to determine SGe.
 - A. Estimate the air dry pounds of the previous crop residue using Tables 5 and 6.
 - B. Estimate the air dry pounds of growing crop.
 - C. Add the pounds of residue and pounds of growing crop for total biomass present and calculate the percent of each component.
 - D. Use the total pounds from "C" and read the SGe from the appropriate conversion curve for each component.
 - E. Multiply the pounds SGe from "D" by the appropriate percentage from "C."
 - F. Add the results from "E" for the SGe for that crop management period.
8. Use the appropriate E Table (Appendix A) for the selected I, K, C, L, and V to determine an annual soil erosion rate for each crop management period.

9. From Chart 5 or Table 10 select the appropriate Erosive Wind Energy (EWE) Distribution Curve and calculate the percent EWE that occurs during each crop management period.
10. For each crop management period multiply E by the percent EWE. This is the estimated wind erosion (tons/acre) for each management period. The sum of these values for a single crop would be the annual wind erosion rate in tons/acre/year. The sum of these values for a crop sequence divided by the number of years in the sequence would be the average annual wind erosion rate in tons/acre/year for the crop sequence.

11. Guidelines for Estimating Wind Erosion

In general, for most crops, the period from 50 percent canopy through harvest are protected from wind erosion by the growing crop. Enter estimated soil loss = 0 for the period.

For high and medium residue crops (such as small grains, corn for grain, etc.,) the untilled, standing stubble following harvest usually provides complete protection from wind erosion. Enter estimated soil loss = 0 for this period.

For some low residue crops (such as soybeans, corn silage, sunflowers), the management period following harvest may be subject to wind erosion. Soil loss calculations for the period following harvest will estimate the potential soil loss for period when standing stubble does not provide complete protection.

In most cases, crop management periods, during the early stages of crop development, are subject to wind erosion.

12. Use the example worksheet provided in Appendix A to estimate wind erosion using the crop management period method.

CHART 5

South Dakota Erosive Wind Energy (EWE) Areas

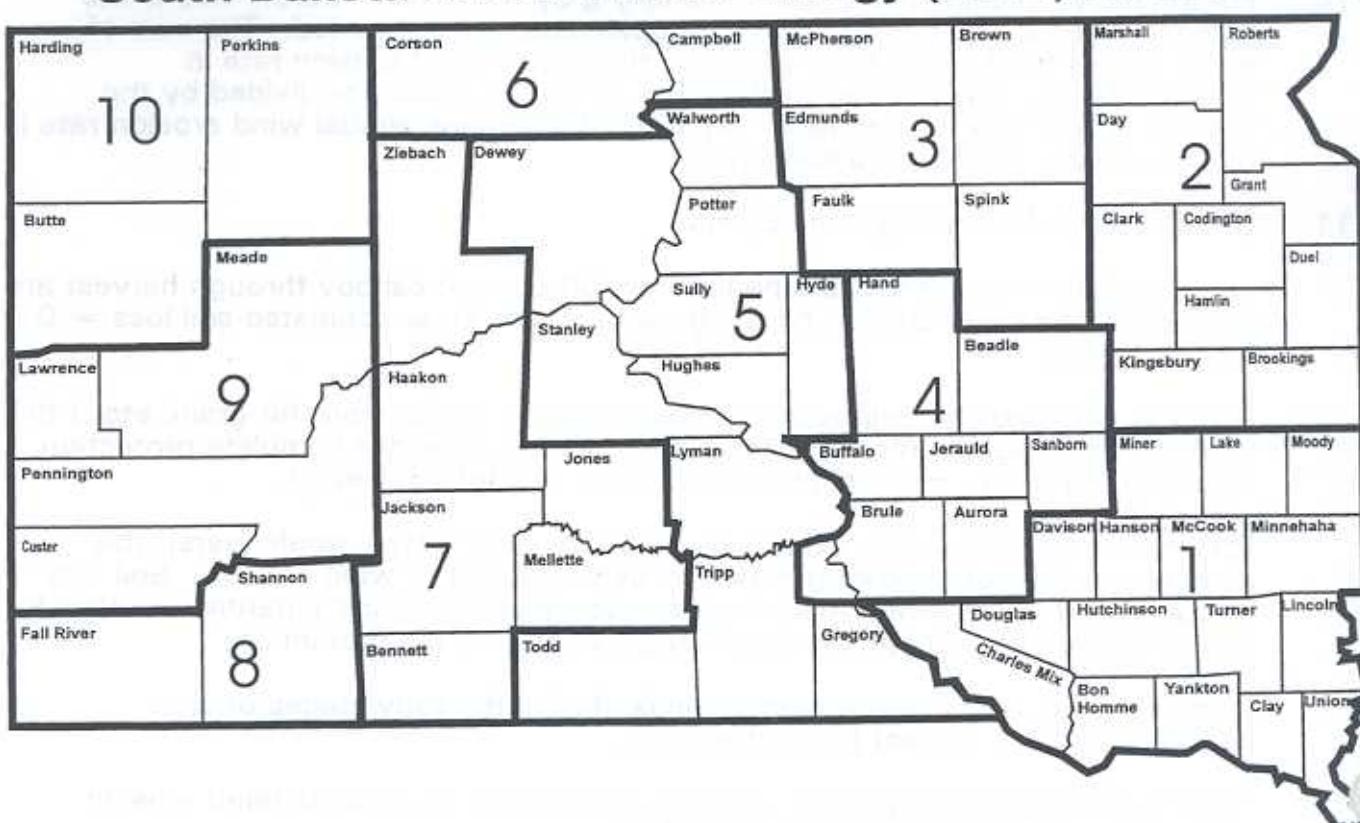


TABLE 9
CROP DEVELOPMENT INTERVALS

Crop	Average Pltg. Date	Days From Planting To Percent Canopy		
		10%	50%	75%
Corn	5/5	30	50	70
Soybeans	5/10	30	50	70
Oats	4/10	30	50	60
Barley	4/15	30	50	60
Spring Wheat	4/15	30	50	60
Winter Wheat	9/15	20	50	245
Rye	9/15	20	50	245
Potatoes	5/1	25	45	60
Sunflowers	6/1	30	50	70
Flax	5/1	35	65	75
Millet	6/1	20	35	45
Alfalfa	4/15	30	55	75
Alfalfa	8/1	30	60	305
Peas	5/1	15	25	30

TABLE 10

**PREVAILING WIND DIRECTION (PWD),
PREPONDERANCE (PREP) OF WIND EROSION FORCES AND
EROSSIVE WIND ENERGY (EWE)**

EWE AREA 1												
LOCATION - SIOUX FALLS, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	315	337	337	315	180	180	180	180	337	0	315
PREP	4.4	1.9	2.3	1.8	1.5	2.0	2.1	2.4	2.1	2.3	3.4	3.2
EWE	10.5	7.4	14.8	20.2	10.3	5.0	2.9	2.7	3.4	7.9	8.0	6.9
EWE AREA 2												
LOCATION - WATERTOWN, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	337	315	0	337	293	293	158	180	293	158	315	315
PREP	3.1	1.3	1.5	1.8	2.0	1.2	2.7	2.0	1.9	2.0	2.7	2.2
EWE	6.8	6.3	16.3	18.9	10.7	7.0	2.9	2.2	6.0	8.3	9.0	5.1
EWE AREA 3												
LOCATION - ABERDEEN, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	337	337	0	0	337	158	158	158	157	338	338	338
PREP	2.9	1.9	4.0	1.9	1.4	1.8	2.7	2.1	2.1	2.8	2.7	2.7
EWE	8.7	9.6	14.1	18.2	13.6	3.7	2.6	4.2	5.6	7.6	6.6	5.5
EWE AREA 4												
LOCATION - HURON, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	315	337	337	337	157	180	180	158	315	315	315
PREP	3.3	2.8	4.0	2.6	1.9	2.5	3.2	2.7	2.5	2.7	2.5	4.0
EWE	9.1	7.5	14.3	16.7	10.4	5.2	3.6	4.7	6.9	7.2	7.8	6.7
EWE AREA 5												
LOCATION - PIERRE, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	315	315	315	315	135	135	135	315	315	315	315
PREP	2.9	3.0	2.3	2.3	2.0	2.5	1.9	2.1	2.2	3.2	3.7	4.0
EWE	11.8	8.0	13.4	15.1	10.0	4.3	3.6	4.7	6.5	6.8	6.9	8.9
EWE AREA 6												
LOCATION - BISMARCK, ND				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	315	337	315	315	293	315	337	315	315	315	315
PREP	3.9	4.0	2.6	2.0	1.8	1.5	2.3	2.4	2.4	3.9	3.3	4.0
EWE	9.5	7.6	11.4	13.4	13.5	5.2	3.6	4.9	7.0	9.9	6.5	7.5

TABLE 10 (cont.)

**PREVAILING WIND DIRECTION (PWD),
PREPONDERANCE (PREP) OF WIND EROSION FORCES AND
EROSIVE WIND ENERGY (EWE)**

EWE AREA 7												
LOCATION - PHILIP, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	337	337	337	315	337	337	338	180	337	337	315	337
PREP	4.0	4.0	4.0	3.9	3.0	2.7	2.1	2.0	2.8	4.0	4.0	4.0
EWE	10.2	5.3	14.9	18.7	9.5	5.5	3.9	4.3	5.1	5.0	10.3	7.3

EWE AREA 8												
LOCATION - CHADRON, NE				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	45	315	157	158	180	180	180	180	180	337	337
PREP	2.2	1.4	2.9	2.5	2.7	2.7	2.9	3.9	3.0	2.4	2.5	2.6
EWE	5.1	5.4	13.1	17.3	10.1	6.0	7.0	7.4	7.0	6.7	9.3	5.6

EWE AREA 9												
LOCATION - RAPID CITY, SD				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	337	315	315	315	135	135	135	315	315	315	315
PREP	2.9	3.0	2.3	2.3	2.0	2.5	1.9	2.1	2.2	3.2	3.7	4.0
EWE	11.8	8.0	13.4	15.1	10.0	4.3	3.6	4.7	6.5	6.8	6.9	8.9

EWE AREA 10												
LOCATION - DICKINSON, ND				MONTH								
ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PWD	315	293	315	315	315	293	315	157	293	315	293	293
PREP	2.8	2.7	3.0	2.7	3.3	2.9	2.4	2.9	3.3	3.0	3.5	3.5
EWE	10.6	8.5	13.3	12.7	9.0	6.6	3.3	3.4	6.4	7.3	10.5	8.4

TABLE 11
WIND EROSION DIRECTION FACTOR

Preponderance	ANGLE OF DEVIATION ^{1/} = 0°						
	1:1	2:1	4:1	8:1	10:1	12:1	16:1
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.30	1.45	1.53	1.56	1.58	1.62
1.4	1.03	1.20	1.28	1.32	1.35	1.37	1.40
1.6	1.03	1.14	1.18	1.20	1.22	1.23	1.25
1.8	1.03	1.10	1.11	1.12	1.13	1.14	1.15
2.0	1.02	1.07	1.07	1.07	1.08	1.08	1.08
2.2	1.02	1.05	1.05	1.05	1.05	1.05	1.05
2.4	1.02	1.04	1.04	1.04	1.04	1.04	1.04
2.6	1.01	1.03	1.03	1.03	1.03	1.03	1.03
2.8	1.01	1.02	1.02	1.02	1.02	1.02	1.02
3.0	1.01	1.02	1.02	1.02	1.02	1.02	1.02
3.2	1.01	1.01	1.01	1.01	1.01	1.01	1.01
3.4	1.01	1.01	1.01	1.01	1.01	1.01	1.01
3.6	1.00	1.01	1.01	1.01	1.01	1.01	1.01
3.8	1.00	1.01	1.01	1.01	1.01	1.01	1.01
4.0	1.00	1.01	1.01	1.01	1.01	1.01	1.01

Preponderance	ANGLE OF DEVIATION = 22.5°						
	1:1	2:1	4:1	8:1	10:1	12:1	16:1
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.37	1.50	1.61	1.64	1.66	1.70
1.4	1.03	1.27	1.36	1.44	1.46	1.47	1.50
1.6	1.03	1.22	1.26	1.30	1.32	1.33	1.35
1.8	1.03	1.18	1.20	1.21	1.22	1.23	1.24
2.0	1.04	1.16	1.16	1.16	1.16	1.16	1.17
2.2	1.05	1.14	1.14	1.14	1.14	1.14	1.14
2.4	1.06	1.13	1.13	1.13	1.13	1.13	1.13
2.6	1.06	1.13	1.13	1.13	1.13	1.13	1.13
2.8	1.07	1.12	1.12	1.12	1.12	1.12	1.12
3.0	1.07	1.12	1.12	1.12	1.12	1.12	1.12
3.2	1.07	1.12	1.12	1.12	1.12	1.12	1.12
3.4	1.08	1.12	1.12	1.12	1.12	1.12	1.12
3.6	1.08	1.11	1.11	1.11	1.11	1.11	1.11
3.8	1.08	1.11	1.11	1.11	1.11	1.11	1.11
4.0	1.08	1.11	1.11	1.11	1.11	1.11	1.11

1/ Angle of deviation is the difference between the prevailing wind erosion direction and a line perpendicular to the long side of the field or strip (the angle of deviation is 0° when the prevailing wind is perpendicular to the long side). Multiply the Wind Erosion Direction Factor times the width of the field for L distance.

ANGLE OF DEVIATION^{1/} = 45°
FIELD LENGTH/WIDTH RATIO

Preponderance	1:1	2:1	4:1	8:1	10:1	12:1	16:1
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.44	1.63	1.72	1.75	1.77	1.81
1.4	1.03	1.42	1.57	1.62	1.65	1.67	1.70
1.6	1.03	1.42	1.52	1.55	1.57	1.58	1.61
1.8	1.03	1.42	1.49	1.51	1.52	1.53	1.55
2.0	1.03	1.42	1.48	1.49	1.49	1.49	1.50
2.2	1.02	1.42	1.48	1.48	1.48	1.48	1.48
2.4	1.02	1.42	1.48	1.48	1.48	1.48	1.48
2.6	1.01	1.42	1.48	1.48	1.48	1.48	1.48
2.8	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.0	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.2	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.4	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.6	1.01	1.42	1.48	1.48	1.48	1.48	1.48
3.8	1.01	1.42	1.48	1.48	1.48	1.48	1.48
4.0	1.01	1.42	1.48	1.48	1.48	1.48	1.48

ANGLE OF DEVIATION^{1/} = 67.5°
FIELD LENGTH/WIDTH RATIO

Preponderance	1:1	2:1	4:1	8:1	10:1	12:1	16:1
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.49	1.80	1.94	1.98	2.00	2.04
1.4	1.03	1.52	1.90	2.03	2.07	2.08	2.12
1.6	1.03	1.55	1.98	2.13	2.15	2.16	2.20
1.8	1.03	1.58	2.08	2.23	2.25	2.26	2.30
2.0	1.04	1.62	2.17	2.35	2.36	2.37	2.40
2.2	1.05	1.65	2.27	2.48	2.49	2.49	2.50
2.4	1.06	1.68	2.37	2.61	2.61	2.61	2.61
2.6	1.06	1.71	2.42	2.71	2.71	2.71	2.71
2.8	1.07	1.72	2.44	2.77	2.77	2.77	2.77
3.0	1.07	1.73	2.45	2.82	2.82	2.82	2.82
3.2	1.07	1.74	2.46	2.85	2.85	2.85	2.85
3.4	1.07	1.75	2.47	2.87	2.87	2.87	2.87
3.6	1.08	1.75	2.48	2.89	2.89	2.89	2.89
3.8	1.08	1.76	2.48	2.90	2.90	2.90	2.90
4.0	1.08	1.76	2.49	2.91	2.91	2.91	2.91

^{1/} Angle of deviation is the difference between the prevailing wind erosion direction and a line perpendicular to the long side of the field or strip (the angle of deviation is 0° when the prevailing wind is perpendicular to the long side). Multiply the Wind Erosion Direction Factor times the width of the field for L distance.

ANGLE OF DEVIATION^{1/} = 90°
FIELD LENGTH/WIDTH RATIO

Preponderance	1:1	2:1	4:1	8:1	10:1	12:1	16:1
1.0	1.03	1.46	1.70	1.85	1.88	1.90	1.95
1.2	1.03	1.50	1.90	2.10	2.16	2.23	2.32
1.4	1.03	1.55	2.10	2.40	2.50	2.60	2.75
1.6	1.03	1.66	2.30	2.70	2.87	3.00	3.25
1.8	1.03	1.80	2.55	3.10	3.32	3.5	3.85
2.0	1.02	1.96	2.78	3.5	3.84	4.08	4.58
2.2	1.02	2.00	3.06	4.05	4.47	4.80	5.40
2.4	1.02	2.00	3.35	4.63	5.12	5.60	6.40
2.6	1.01	2.00	3.56	5.30	5.93	6.50	7.60
2.8	1.01	2.00	3.74	5.85	6.64	7.50	8.90
3.0	1.01	2.00	3.92	6.51	7.60	8.80	10.60
3.2	1.01	2.00	4.00	6.89	8.20	9.30	11.50
3.4	1.01	2.00	4.00	7.08	8.40	9.60	11.80
3.6	1.00	2.00	4.00	7.26	8.60	9.90	12.30
3.8	1.00	2.00	4.00	7.45	8.91	10.30	12.80
4.0	1.00	2.00	4.00	7.64	9.20	10.60	13.30

- 1/ Angle of deviation is the difference between the prevailing wind erosion direction and a line perpendicular to the long side of the field or strip (the angle of deviation is 0° when the prevailing wind is perpendicular to the long side).
 Multiply the Wind Erosion Direction Factor times the width of the field for L distance.

CIRCULAR FIELDS

Unsheltered distance L is equal to 1.83 times the radius of a round field or 0.915 times the diameter of a round field regardless of the prevailing wind direction or preponderance.

SOUTH DAKOTA CROP GROWTH CURVES TABLE 12

CORN

Days after Planting	Days after Emergence	Biomass Dry Weight (lbs.)
7	1	2
15	7	4
22	15	11
30	22	59
37	30	259
45	37	918
52	45	1839
60	52	2560
67	60	3326

SPRING WHEAT

Days after Planting	Days after Emergence	Biomass Dry Weight (lbs.)
7	1	19
15	7	41
22	15	136
30	22	334
37	30	724
45	37	1173
52	45	1753
60	52	2257
67	60	2840

SOYBEAN

Days after Planting	Days after Emergence	Biomass Dry Weight (lbs.)
7	1	1
15	7	10
22	15	20
30	22	53
37	30	177
45	37	624
52	45	1070
60	52	1518
67	60	1937

SOUTH DAKOTA CROP GROWTH CURVES TABLE 12 (cont.)

SUNFLOWER

Days after Planting	Days after Emergence	Biomass Dry Weight (lbs.)
7	1	1
15	7	2
22	15	7
30	22	25
37	30	134
45	37	473
52	45	1183
60	52	1848
67	60	2547

WINTER WHEAT

Days after Planting	Days after Emergence	Biomass Dry Weight (lbs.)
7	1	19
15	7	41
22	15	62
30	22	133
37	30	204
45	37	344
52	45	483
60	52	481
67	60	478

APPENDIX A

INDEX TO SMALL GRAIN EQUIVALENT CHARTS

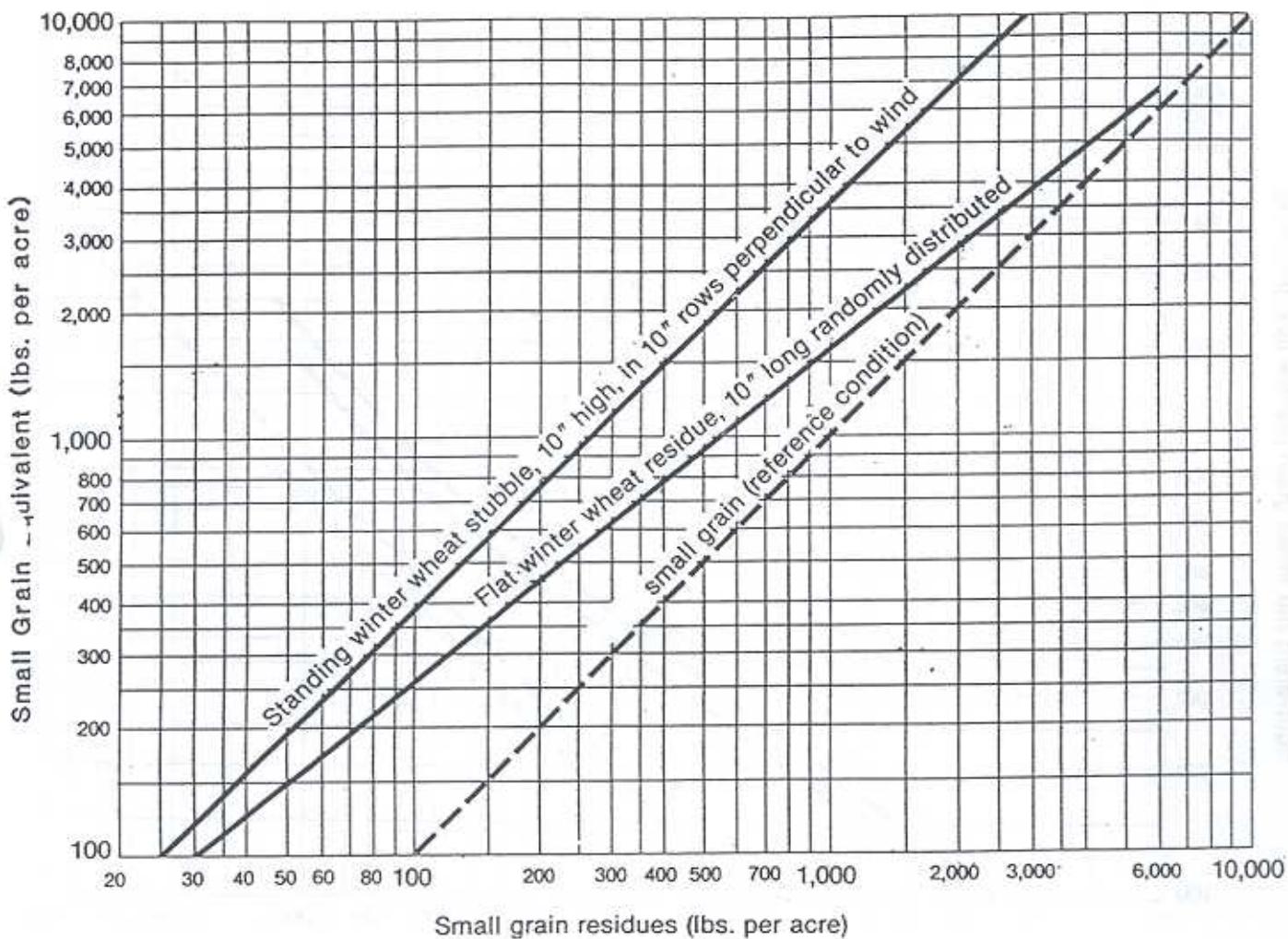
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Chart 4(1)

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Small Grain Equivalents of Small Grain Residues

(Use for wheat, barley, rye and oats)

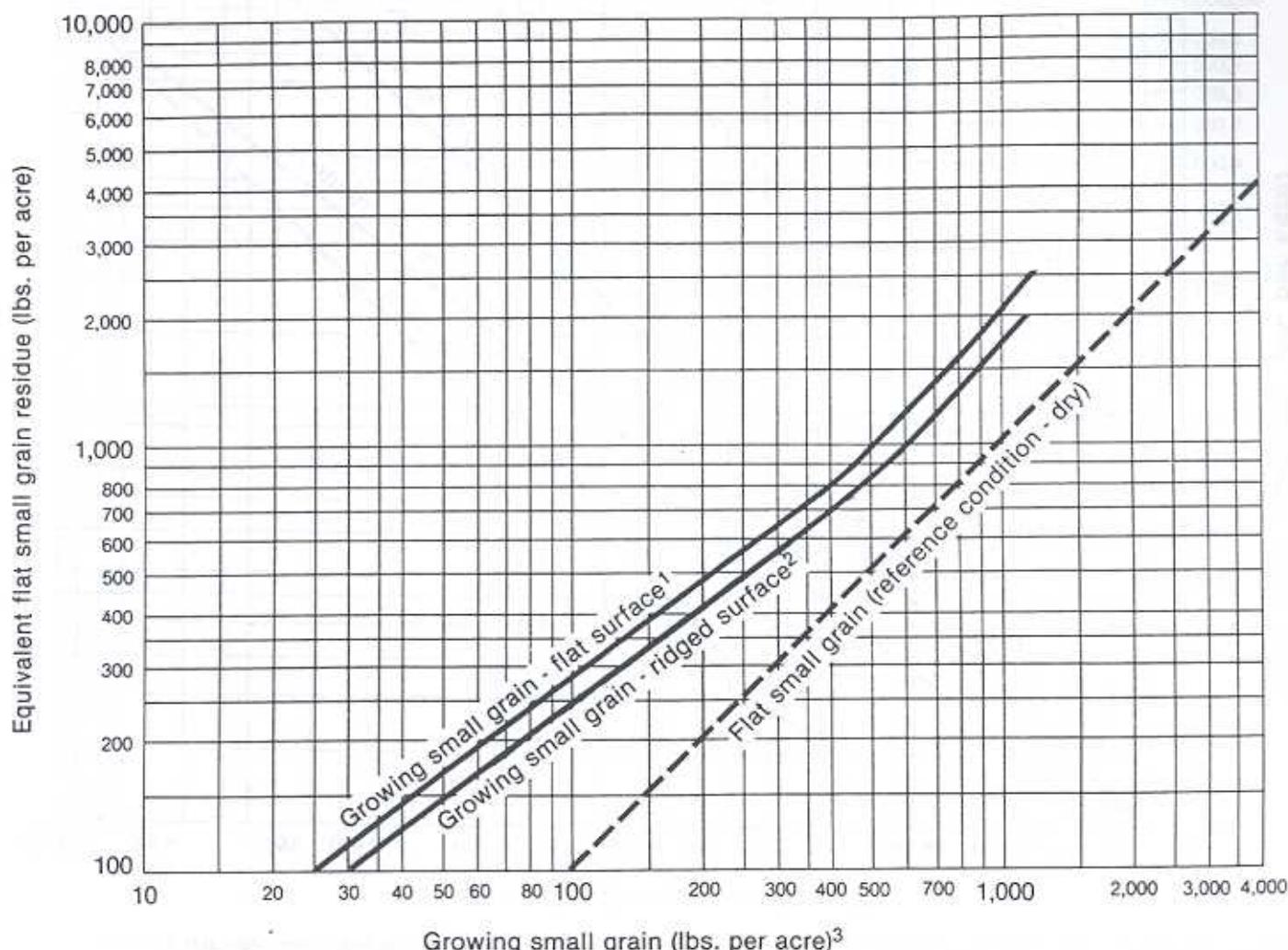


Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison—Trans. ASAE 1981, 24 (2): 405-408.

Residues are washed, air dried, and placed as described for wind tunnel tests.

Flat Small Grain Equivalents of Growing Small Grain



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

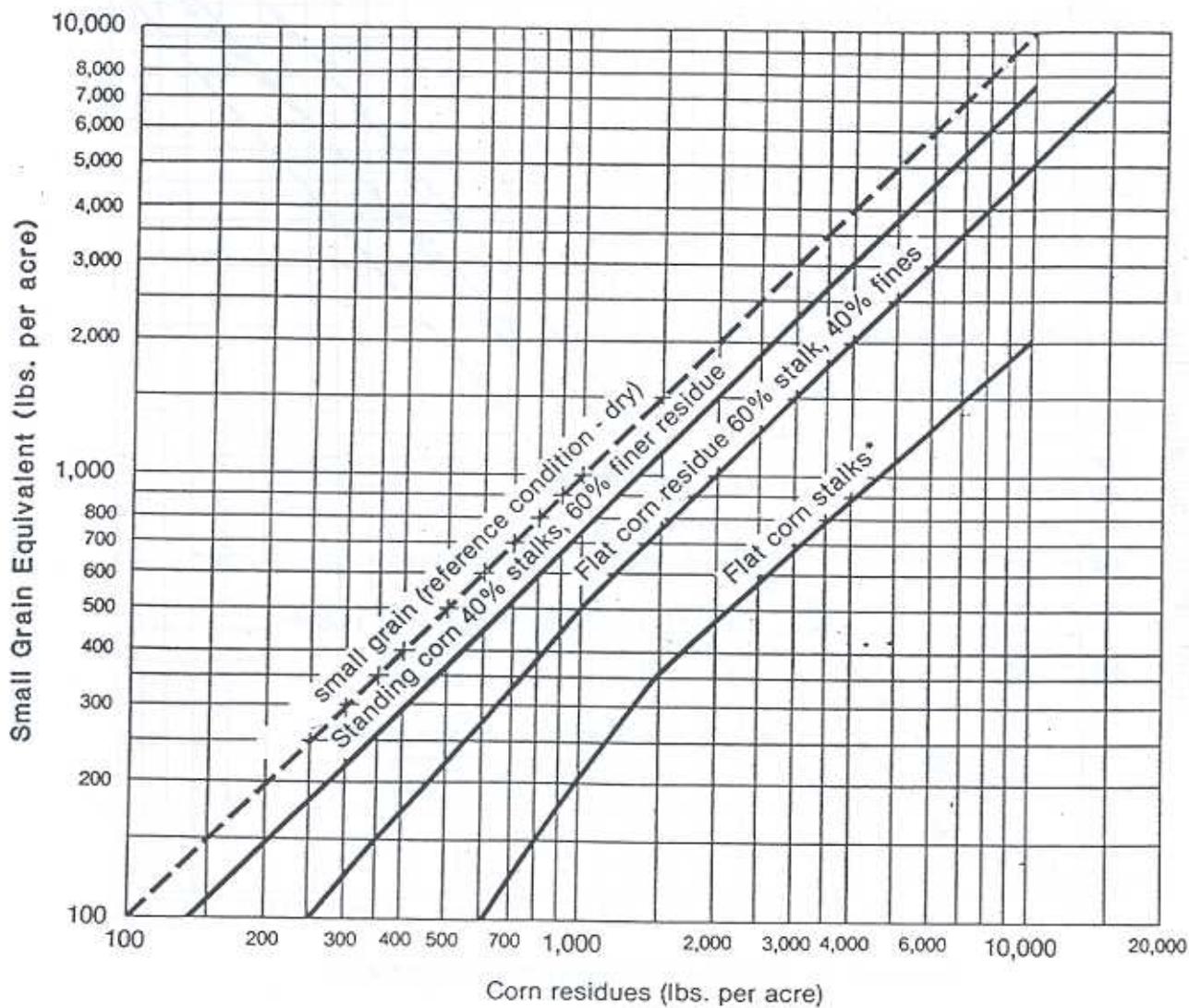
Sources

¹ Siddoway, F.H., W.S. Chepil, and D.V. Armbrust 1965

² Estimates by Best Judgement of SCS Personnel.

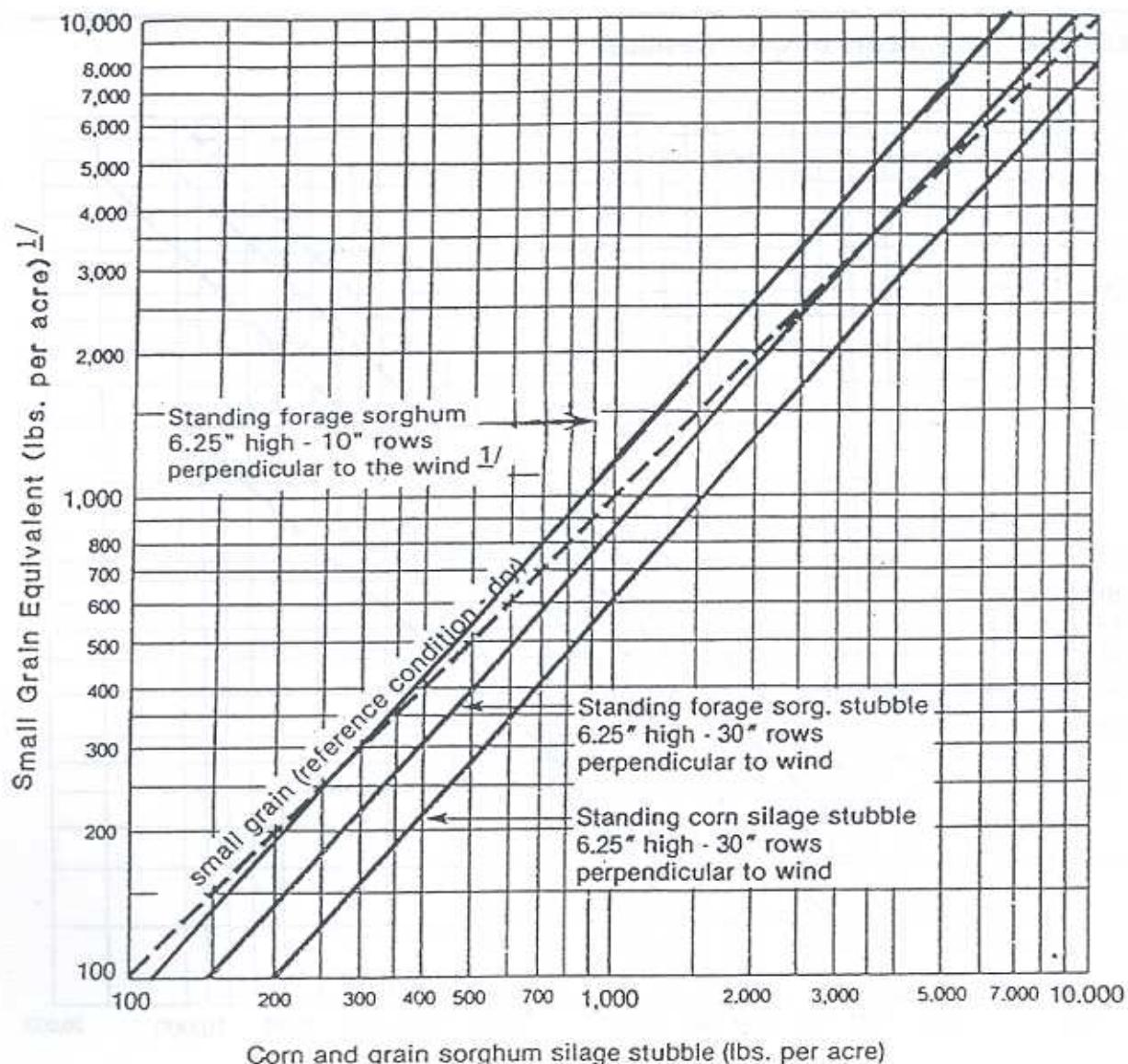
³ Air-dry weights of growing winter wheat from emergence to winter dormancy.

Small Grain Equivalents of Corn Residues



Source*: Lyles and Allison, Trans. ASAE 1981, 24(2): 405-408. (Flat to 2,000 lbs. standing to 3,500 lbs. Extended by SCS.)

Small Grain Equivalents of Corn and Grain Sorghum Silage Stubble



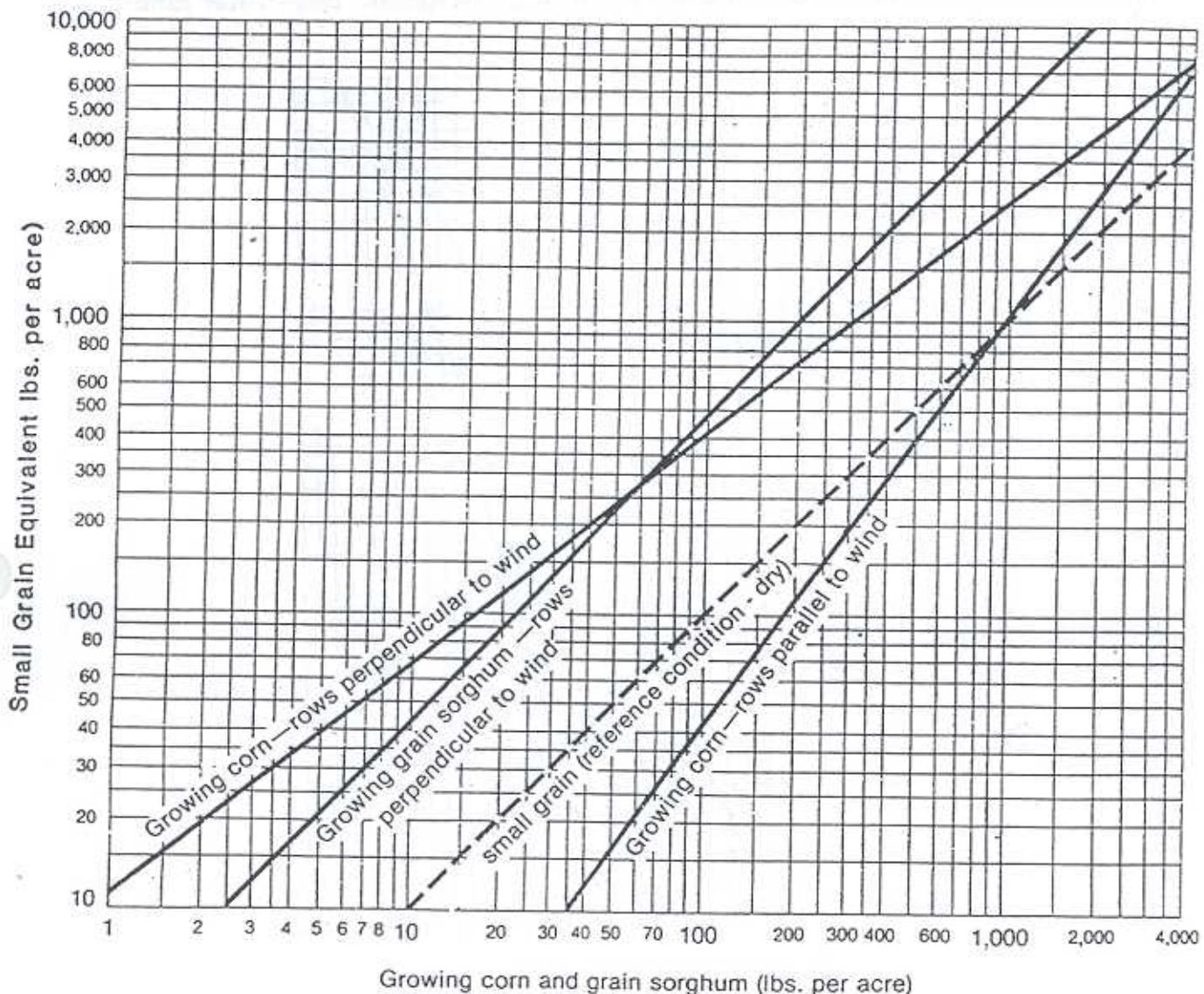
Source: Lyles and Allison, Trans, ASAE 1981, 24(2): 405-408.
Residue weights are washed, air dried, and placed as described for wind tunnel tests.

^{1/} Field Experience in the Northern Plains indicates the ratio of residue to grain is higher when crops, such as forage sorghum, are grown in narrow row seedings. Research is not available at this time to confirm this observation. Until research is available, the residue production values may be increased 30 percent when crops are planted in rows less than 20 inches apart. The line for standing forage sorghum 6.25" high - 10" rows includes an increase of 30 percent over the values for 30" rows.

Chart 4(5)

1985

Small Grain Equivalents of Growing Corn and Grain Sorghum

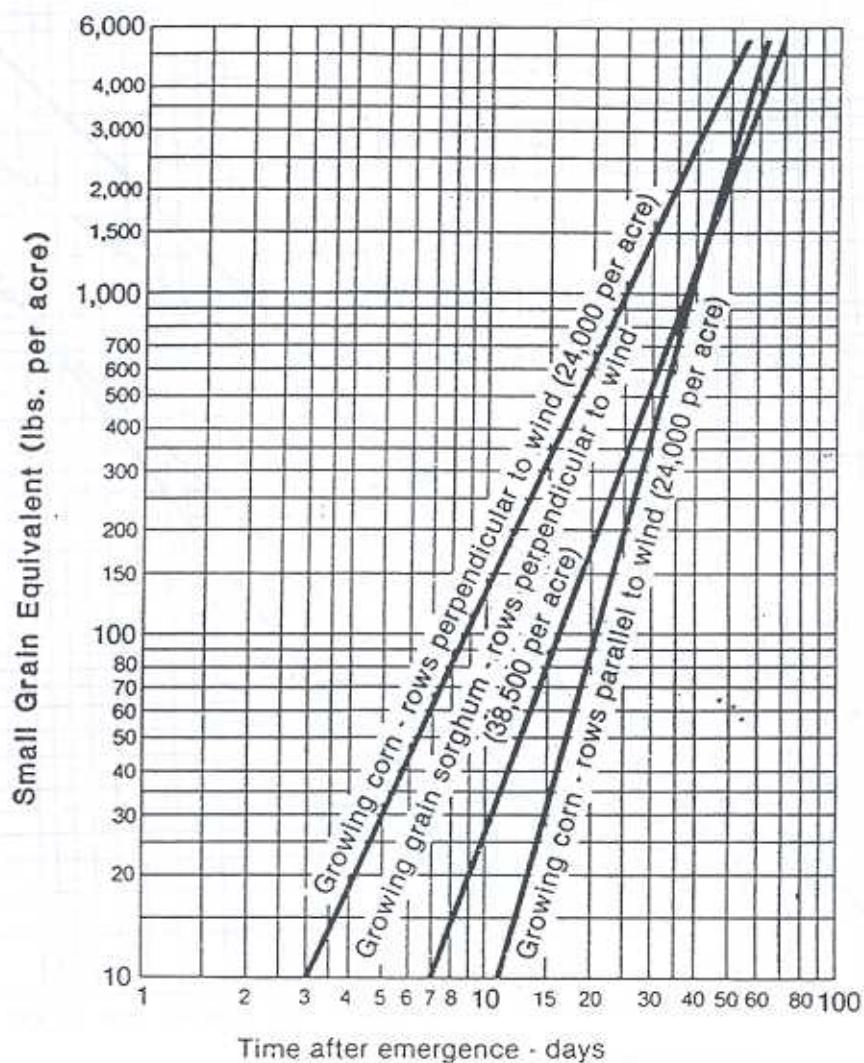


Source: Armbrust & Lyles, 1984 - unpublished

Chart 4(6)

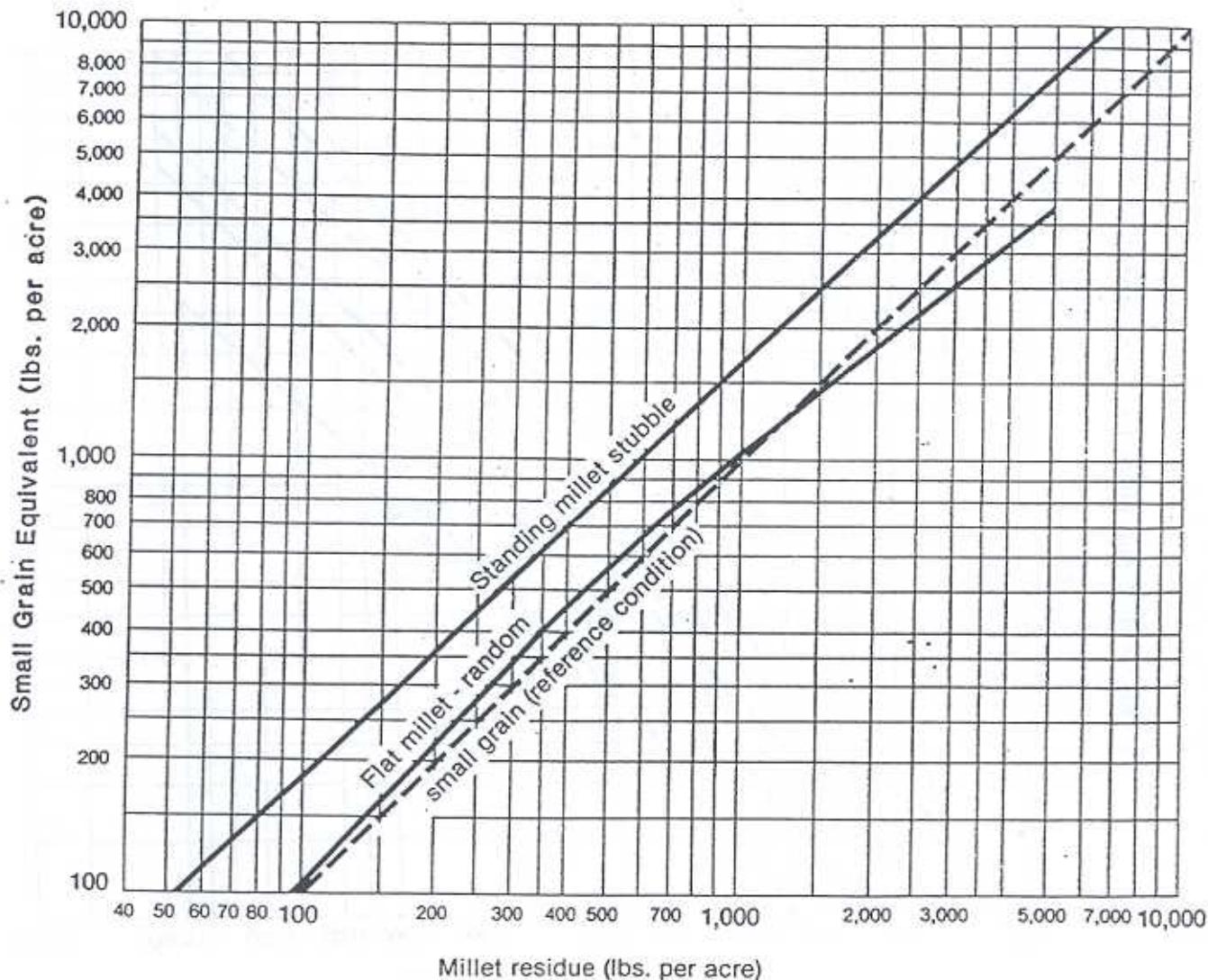
1985

Small Grain Equivalents of Growing Corn and Grain Sorghum, Days After Emergence



Source: Armbrust & Lyles, 1984-unpublished.

Small Grain Equivalents of Millet



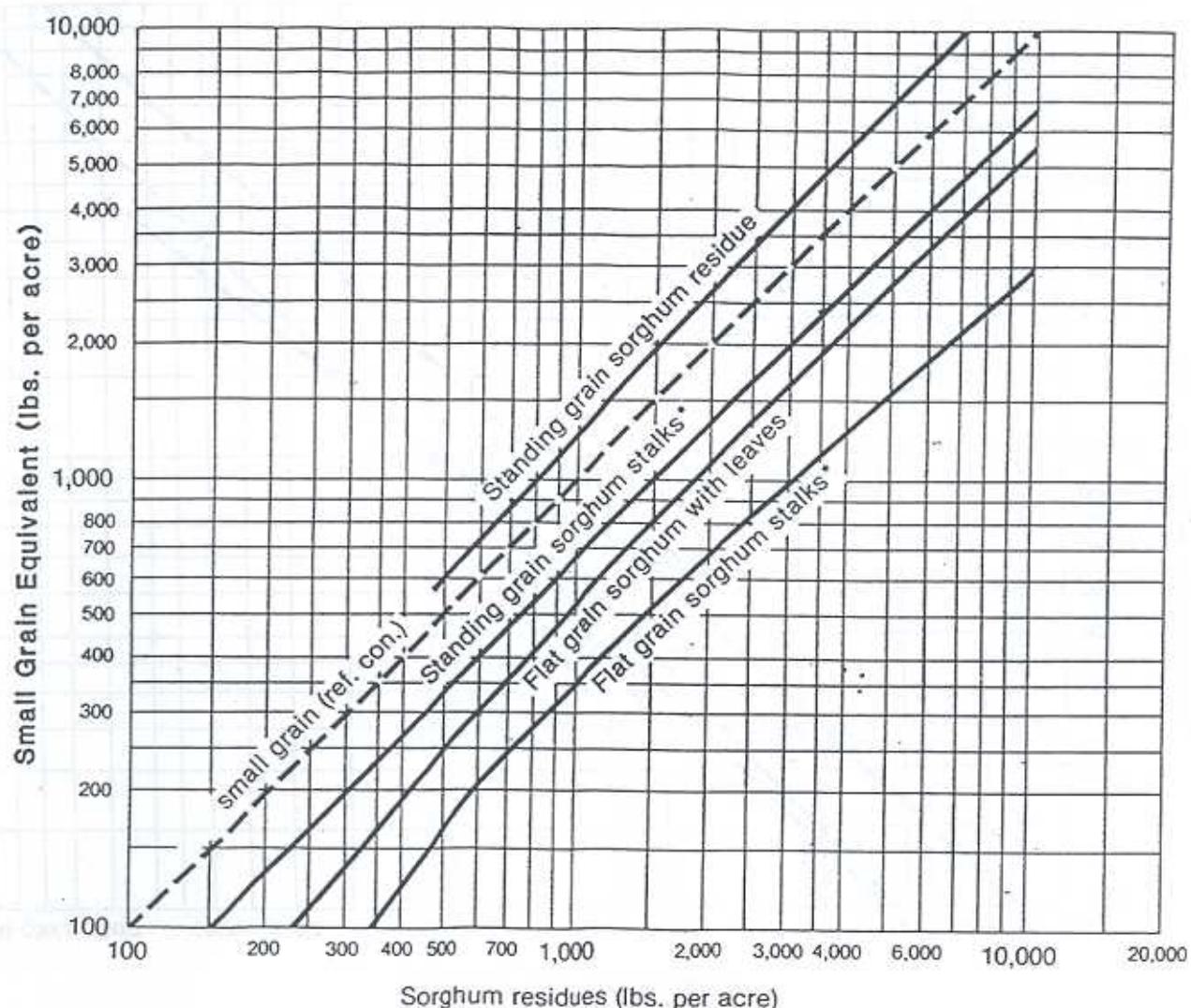
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Leon Lyles, ARS, memorandum, Jan. 25, 1985

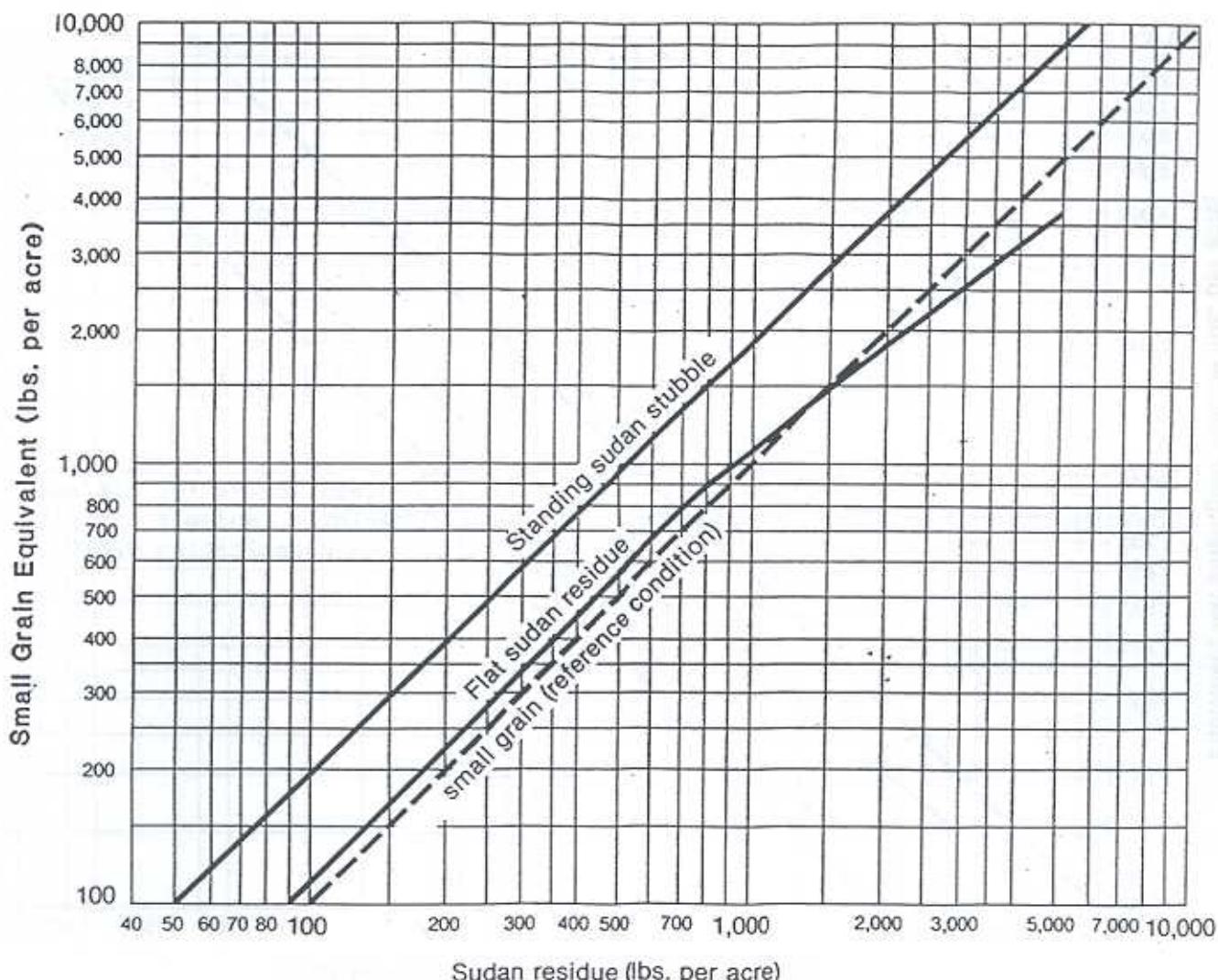
Chart 4(8)

1985

Small Grain Equivalents of Sorghum Residues



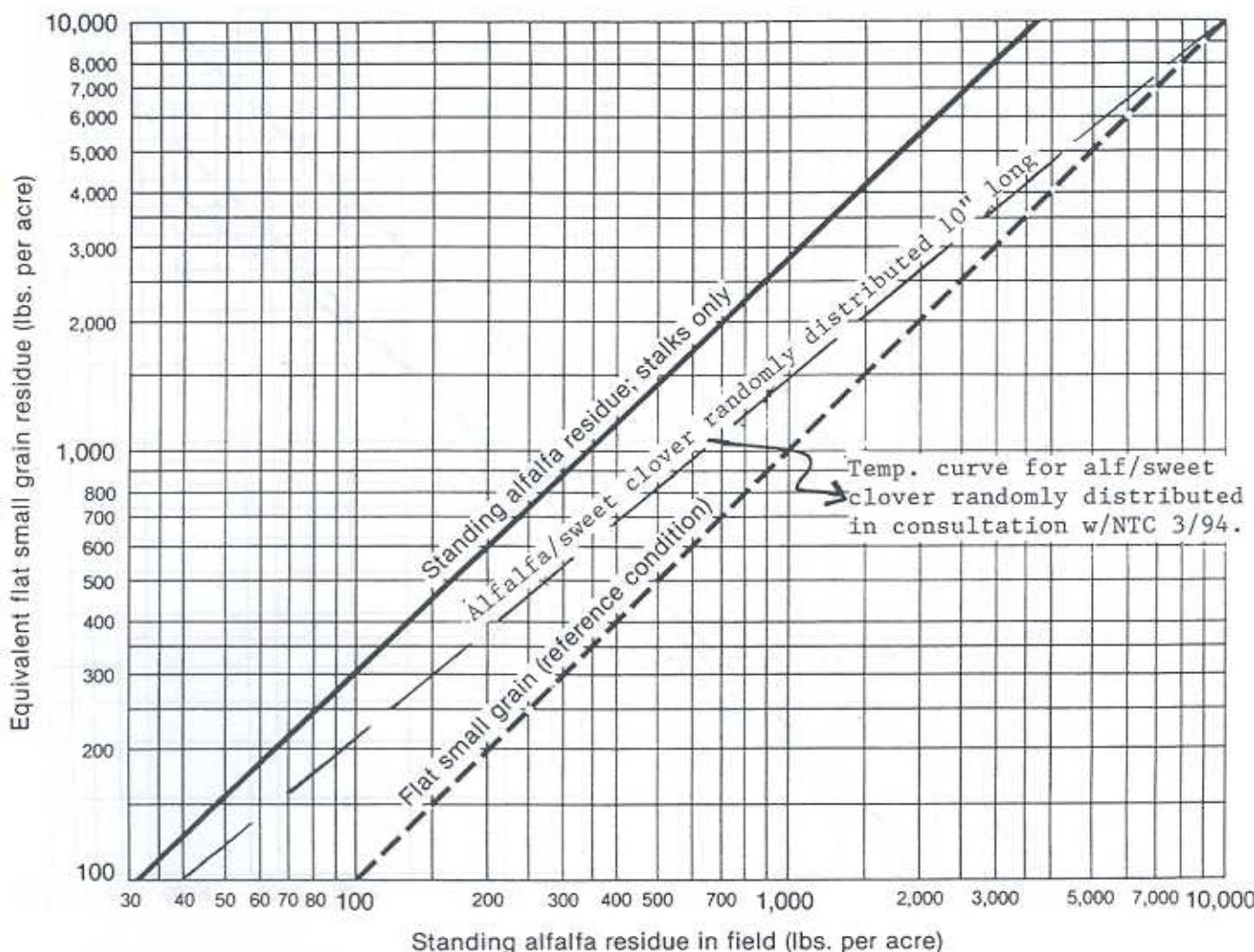
Source*: Lyles and Allison, Trans. ASAE 1981, 24(2): 405-408. (Flat to 2500 lbs. standing stalks to 3500 lbs.) Leafy residue estimates by SCS North Central agronomists, 11/84.

Small Grain Equivalents of Sudan Grass

Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction; stalks oriented to wind direction.

Source: Leon Lyles, ARS, memorandum, Jan. 25, 1985.

Flat Small Grain Equivalents of Alfalfa Residues



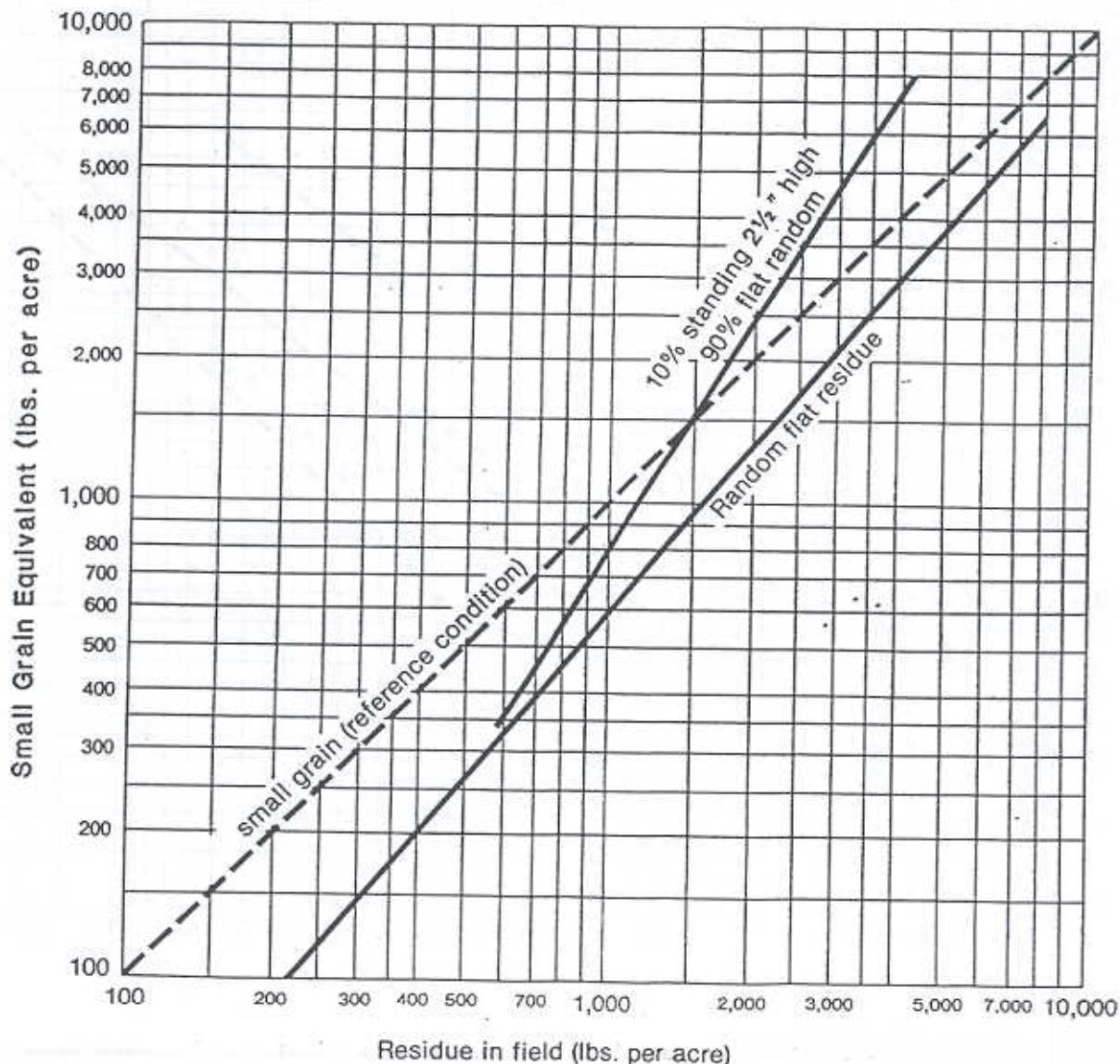
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Unpublished coefficients provided by Leon Lyles, ARS, Wind Erosion Research Unit, Manhattan, KS.

Chart 4(11)

1985

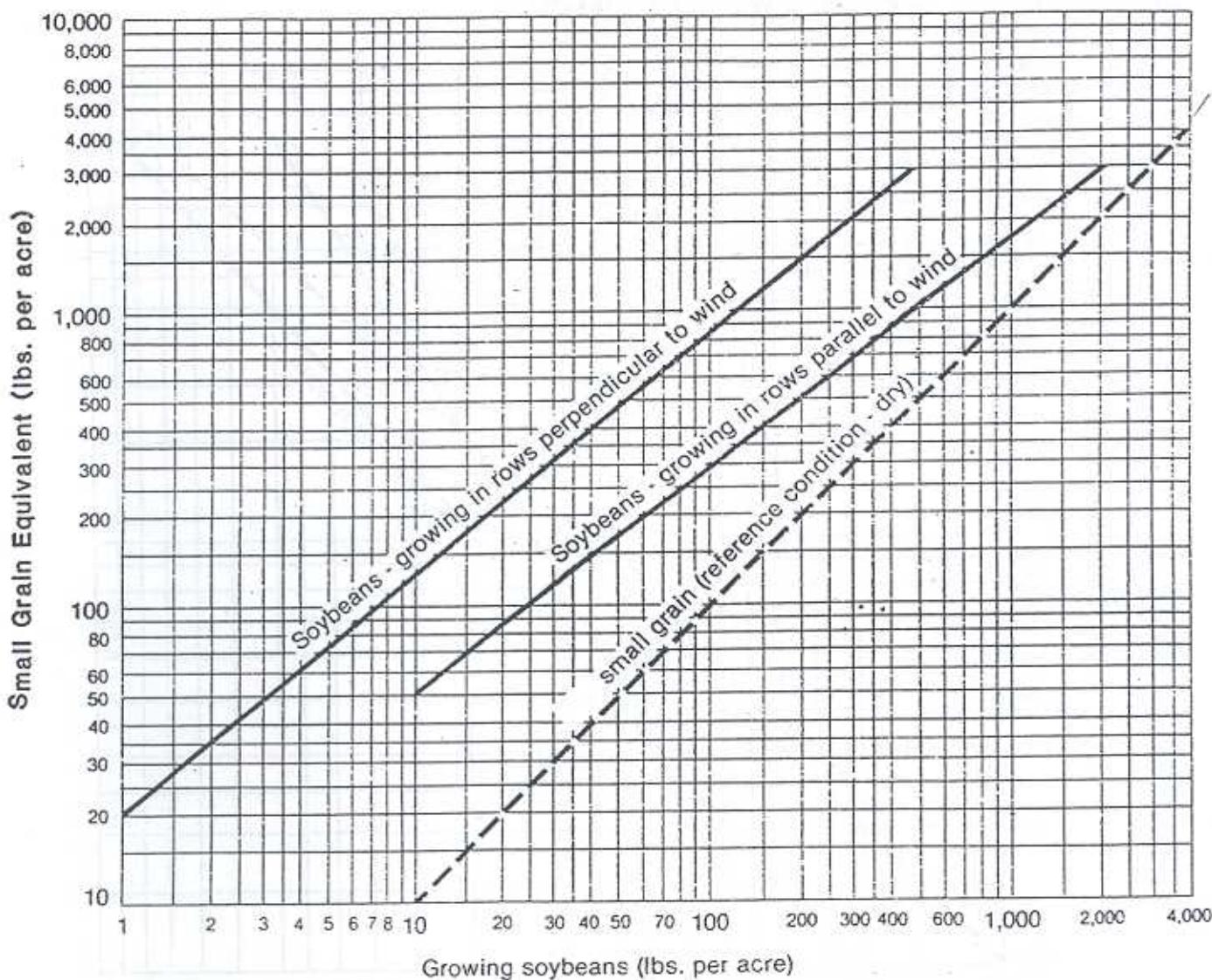
**Small Grain Equivalents
Dry Bean, Lentil, *Soybean, & Winter Pea Residues**



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Best Judgement Estimates by SCS. North Central Agronomists, 11/84.
*Soybeans - Lyles and Allison, Trans. ASAE 1981, 24(2): 405-408.

Small Grain Equivalents of Growing Soybeans

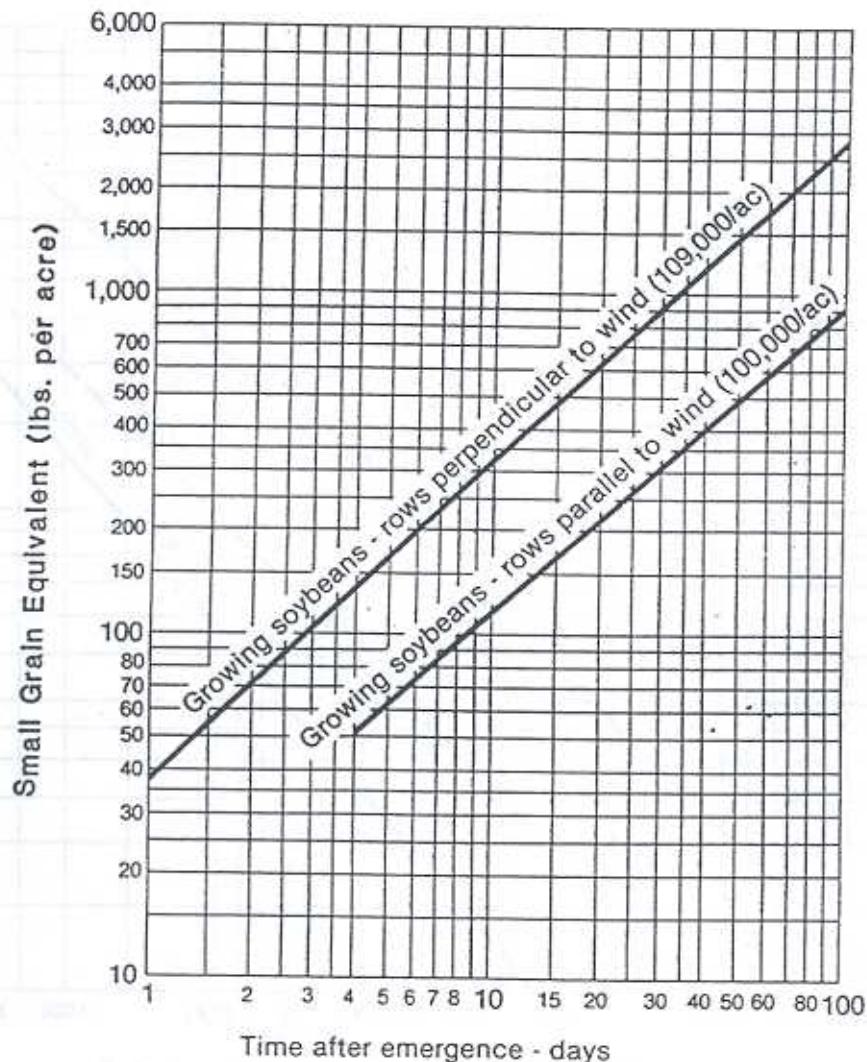


Source: Armbrust & Lyles, 1984-unpublished.

Chart 4(13)

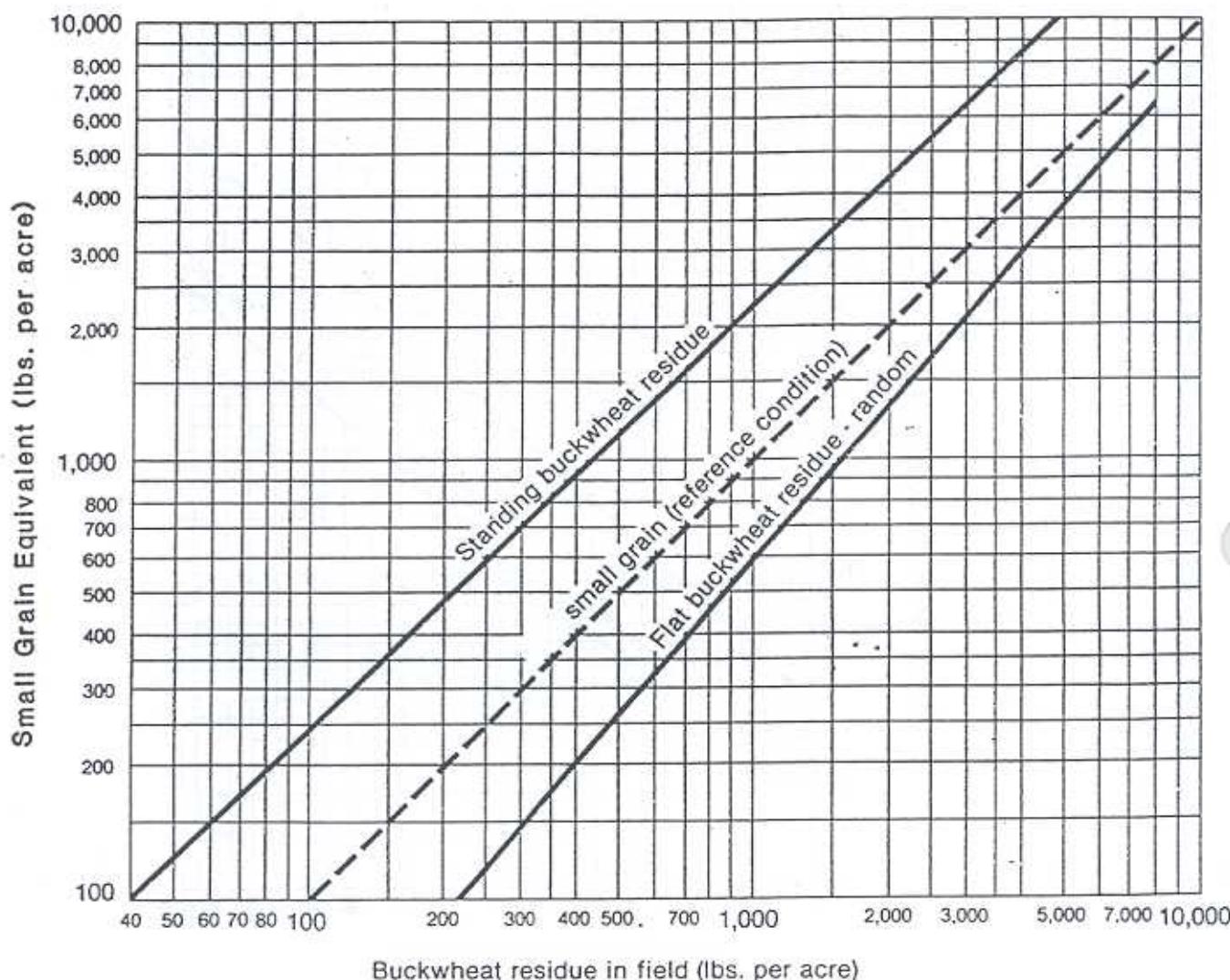
1985

Small Grain Equivalents of Growing Soybeans - Days After Emergence



Source: Armbrust & Lyles, 1984-unpublished.

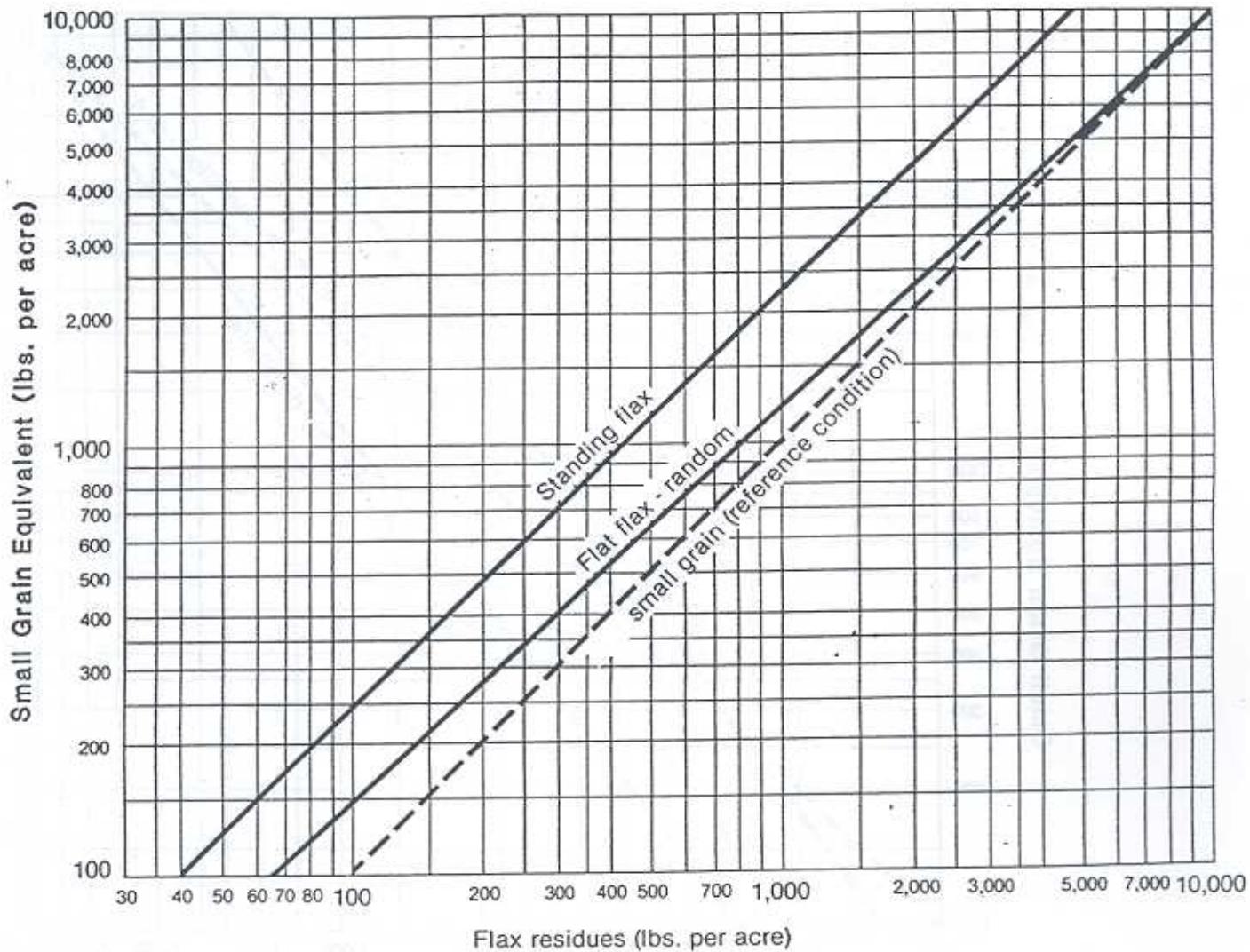
Small Grain Equivalents Buckwheat Residue



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows; rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Best Judgement Estimates by SCS North Central Agronomists, 11/84.

Small Grain Equivalents of Flax Residues



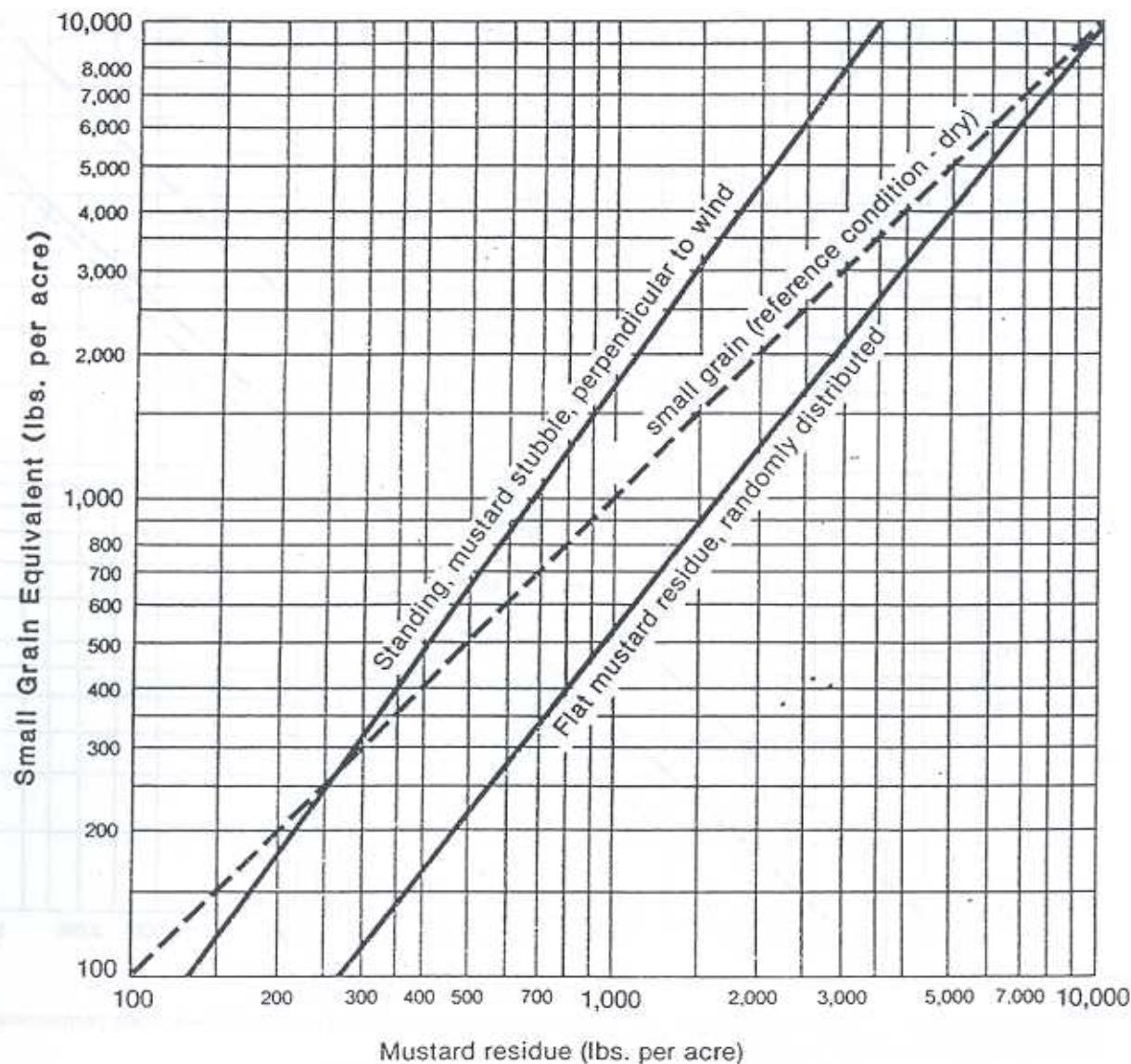
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Best Judgement Estimates by SCS. (North Central Agronomists, 11/84).

Chart 4(16)

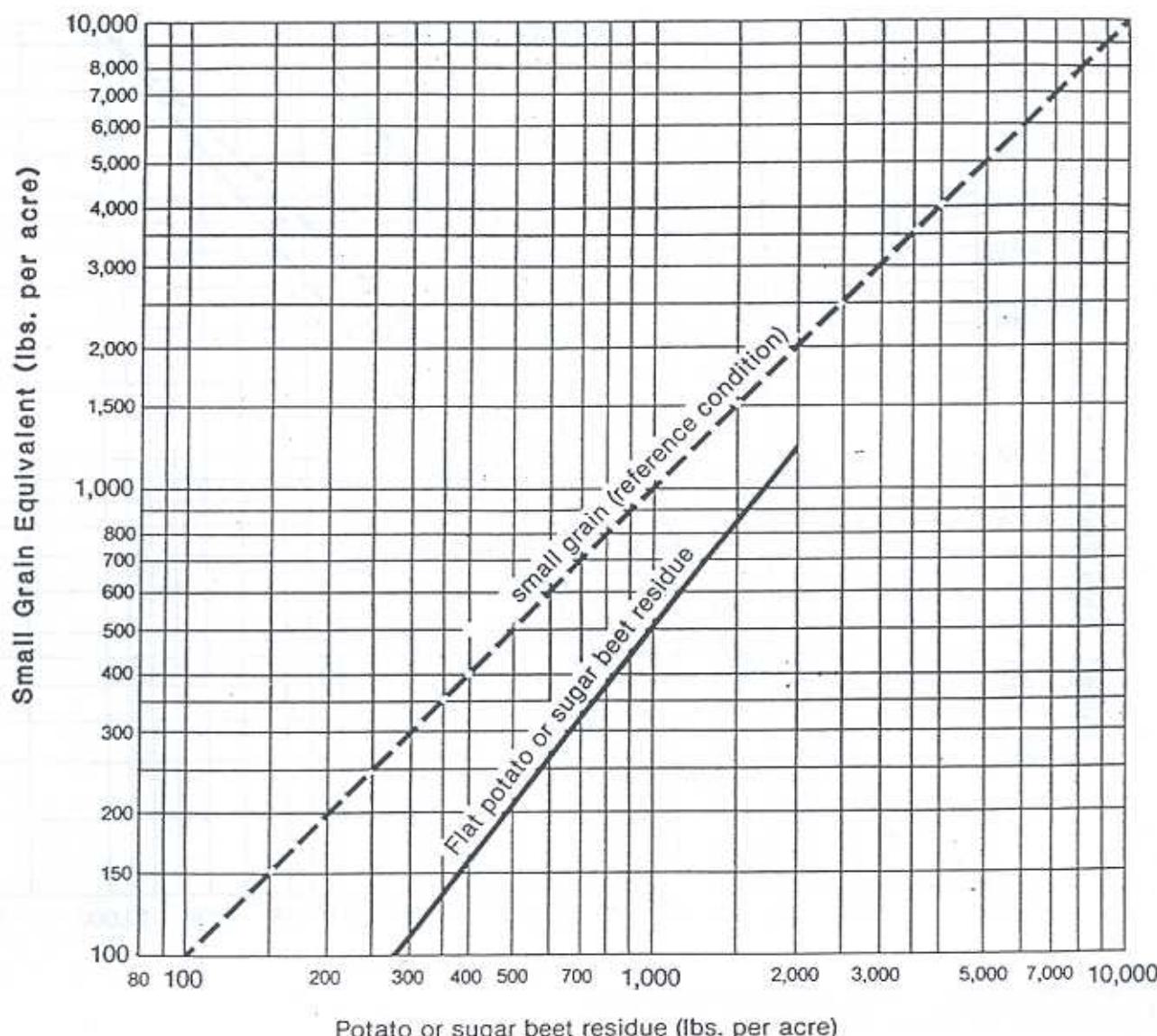
1985

Small Grain Equivalent Mustard Residue



Source: Best Judgement Estimates by SCS, Western Agronomists, 1983.

Small Grain Equivalents of Potato and Sugar Beet Residue



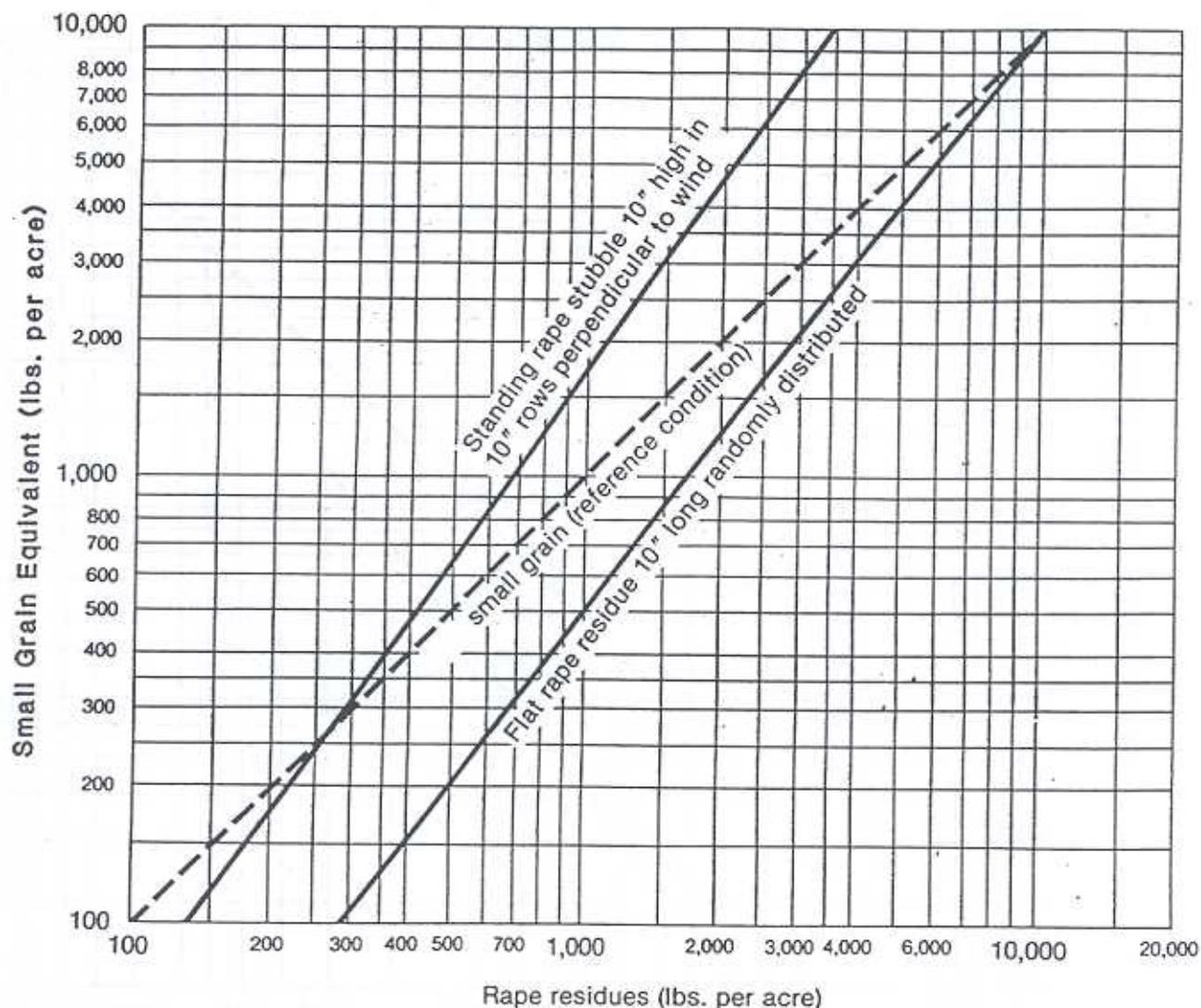
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Best Judgement Estimates by SCS, North Central Agronomists, 11/84.

Chart 4(18)

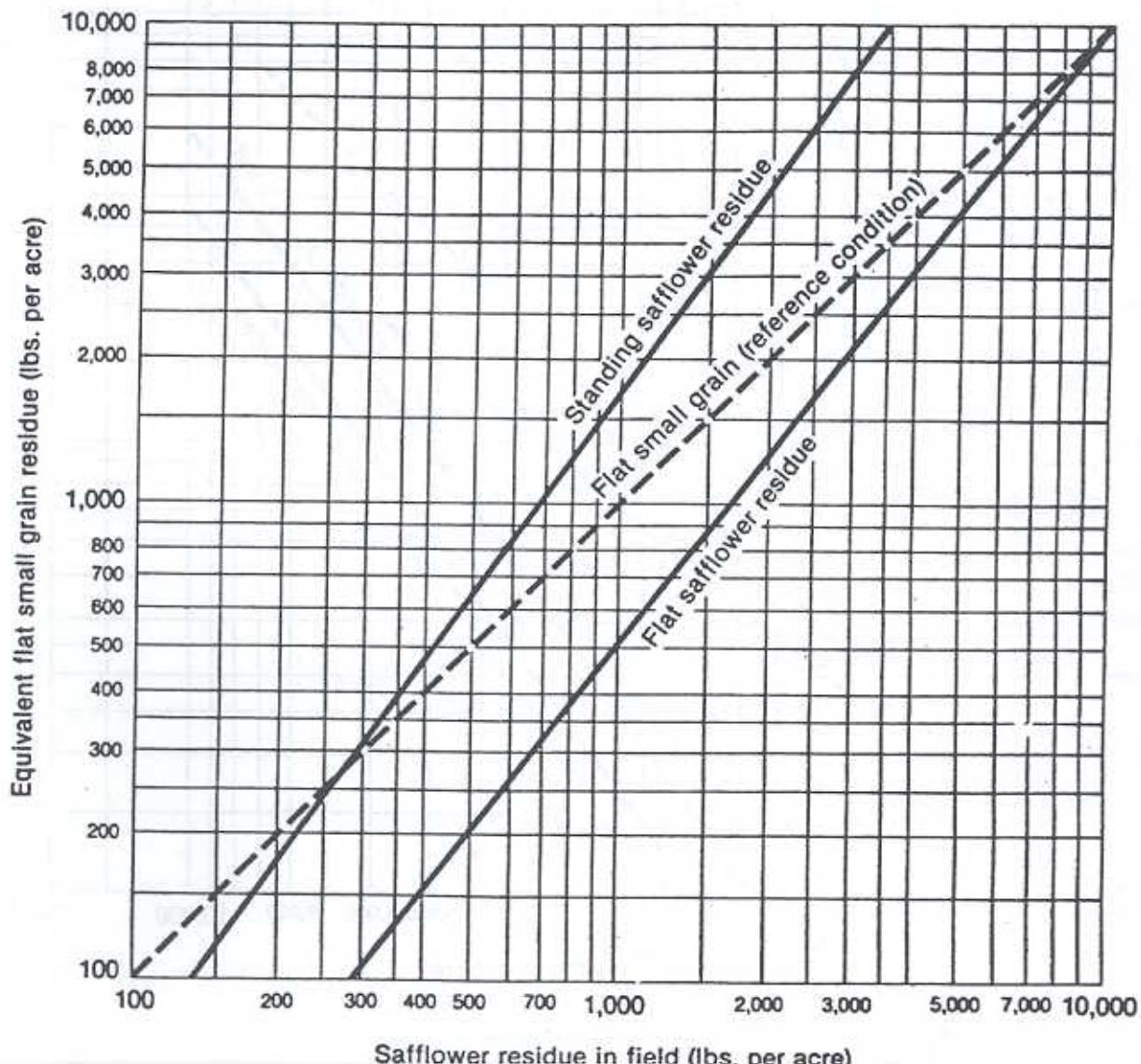
1985

Small Grain Equivalents of Rape Residues



Source: Lyles and Allison, Trans. ASAE 1981, 24(2): 405-408.
Residue wts. are washed, air dried and placed as described.

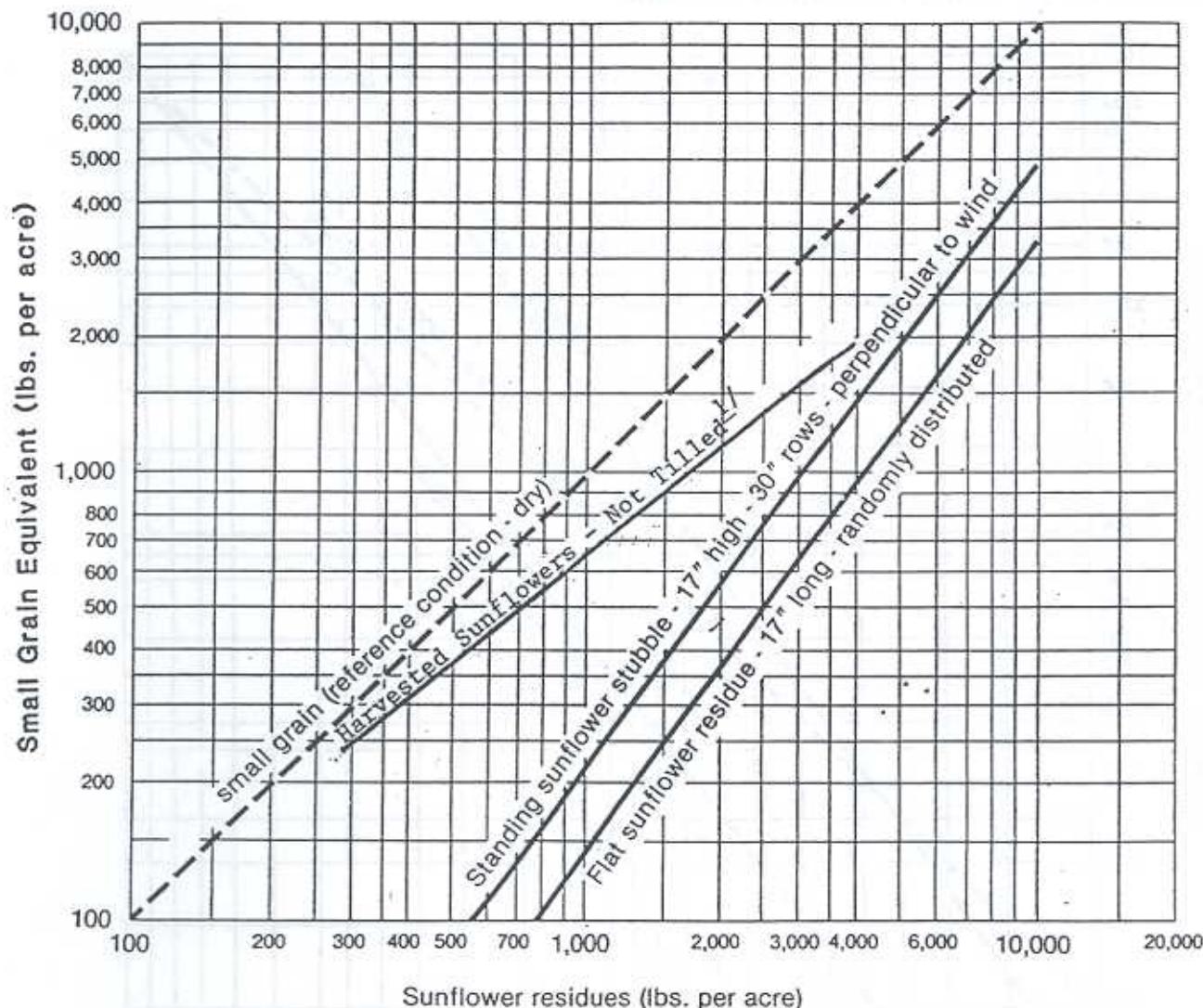
Flat Small Grain Equivalents Safflower Residue



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Best Judgement Estimates by SCS, North Central Agronomists, 11/84.

Small Grain Equivalents of Sunflower Residues



Source: Lyles and Allison, Trans. ASAE 1981, 24(2): 405-408.

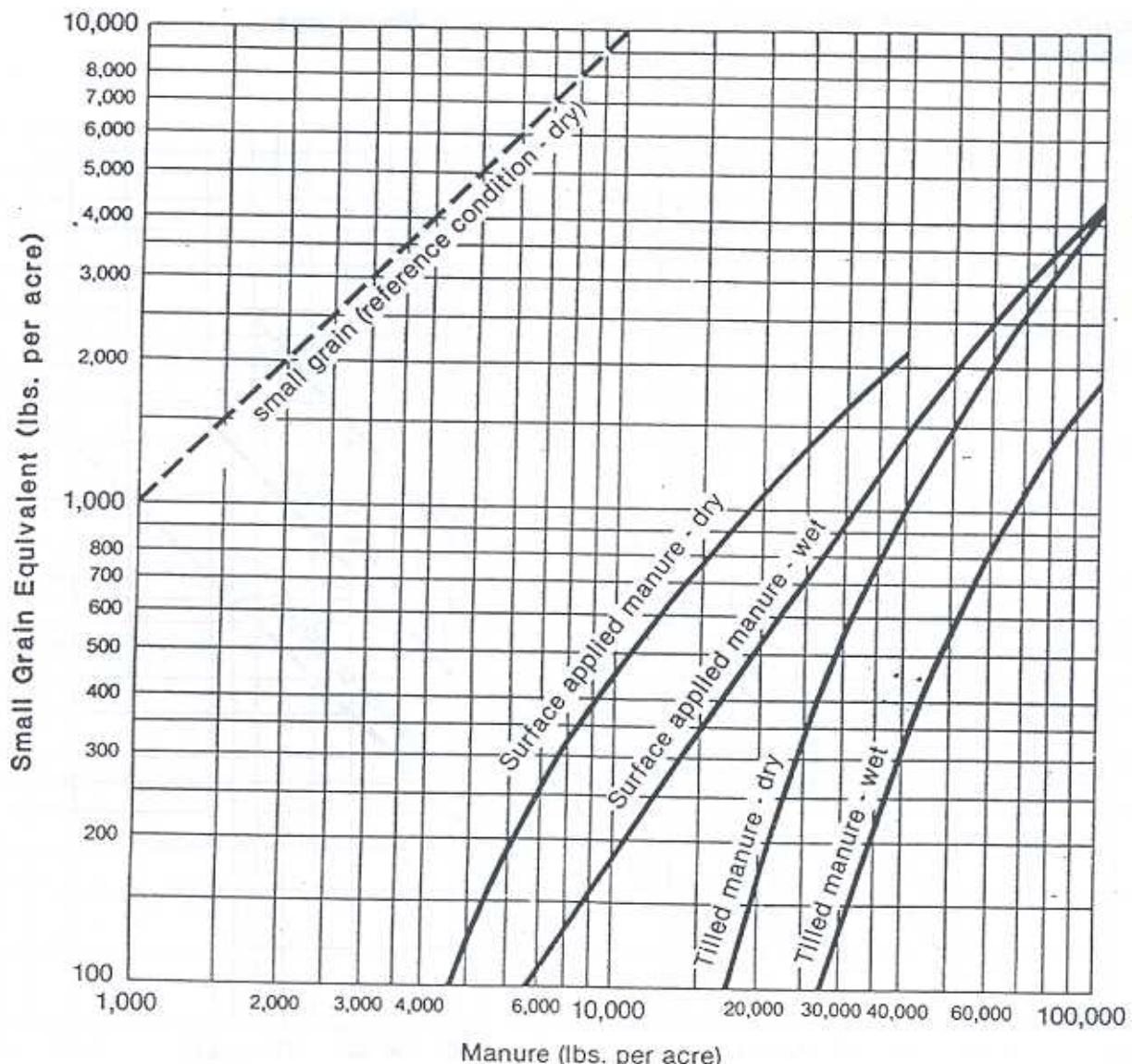
Residue wts. are washed, air dried, and placed as described for wind tunnel test.

^{1/} Twenty-five percent flat sunflower stalks (17" long randomly distributed), 37.5% standing sunflower stalks (17" high - 30 rows - perpendicular to wind), 37.5% flat fine sunflower residue. Used fines curve developed by North Dakota work group 8/87, in combination with previously developed standing and flat sunflower stalk curves. Percents of various components are best judgment estimate by South Dakota work group.

Chart 4(21)

1985

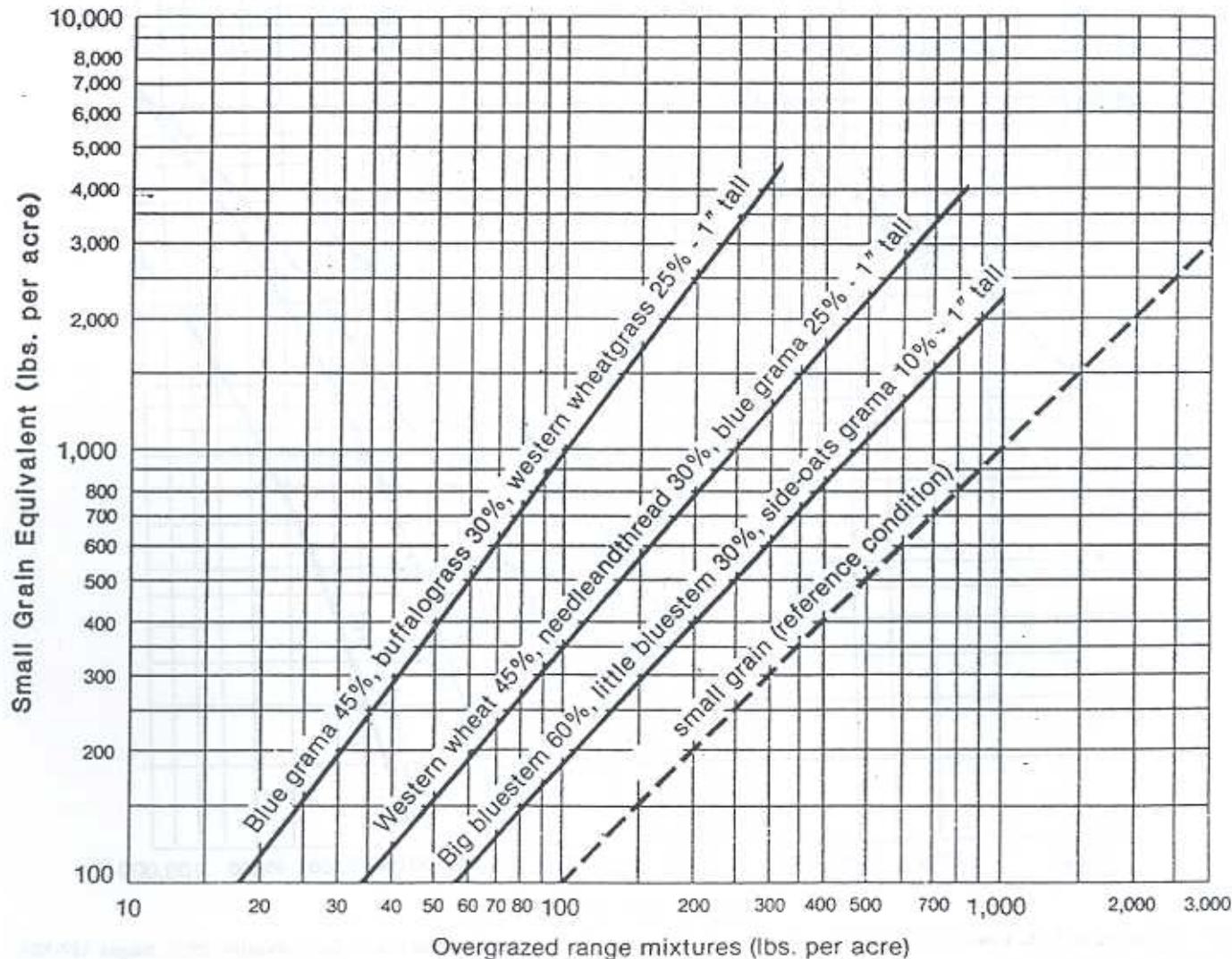
Small Grain Equivalent of Manure



Source: Woodruff, N.P., L. Lyles, J.D. Dickerson, and D.V. Armbrust. 1974 Journal Soil and Water Conservation 29(3), pages 127-129.

Small Grain Equivalents of Overgrazed Range Mixtures.

**Big Bluestem, Little Bluestem, Side-Oats Grama, Western Wheatgrass,
Needleandthread, Blue Grama, and Buffalograss**



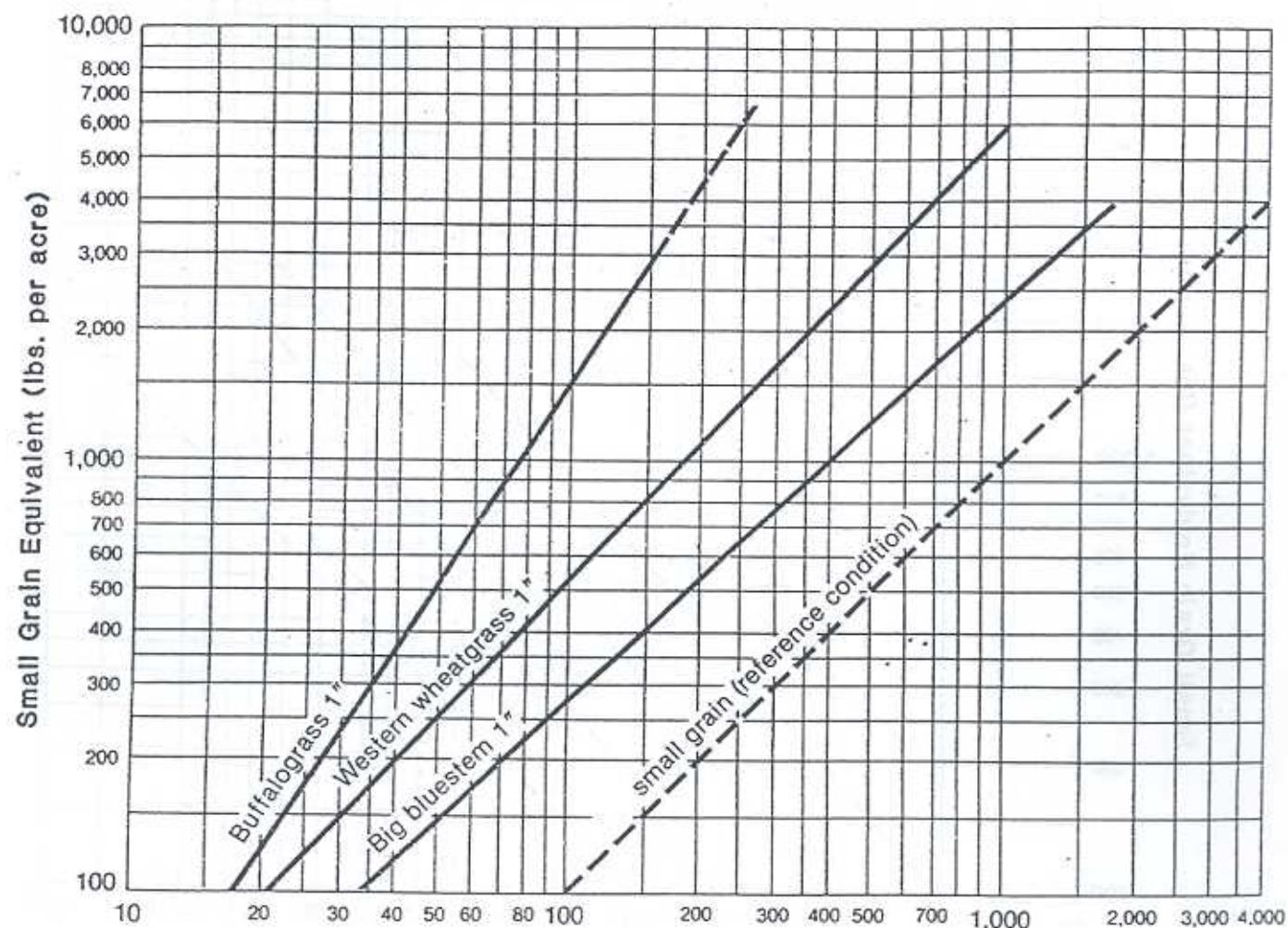
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980 Journal Range Management, 33(2), pages 143 - 146.

Chart 4(23)

1985

Small Grain Equivalents of Overgrazed Big Bluestem, Western Wheatgrass, and Buffalograss

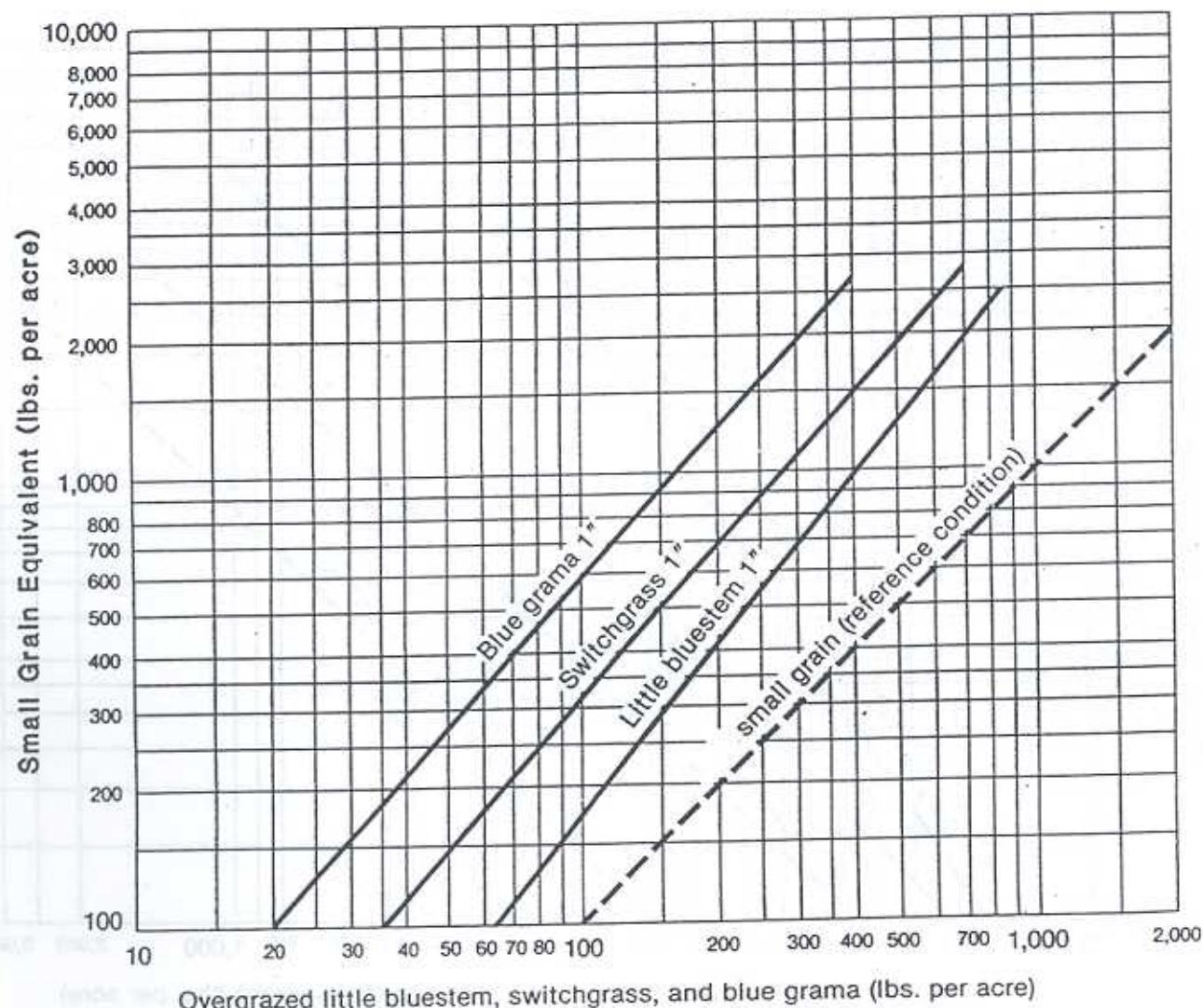


Overgrazed big bluestem, western wheatgrass or buffalograss (lbs. per acre)

Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980 Journal Range Management, 33(2), pages 143-146.

Small Grain Equivalents of Overgrazed Little Bluestem, Switchgrass, and Blue Grama



Overgrazed little bluestem, switchgrass, and blue grama (lbs. per acre)

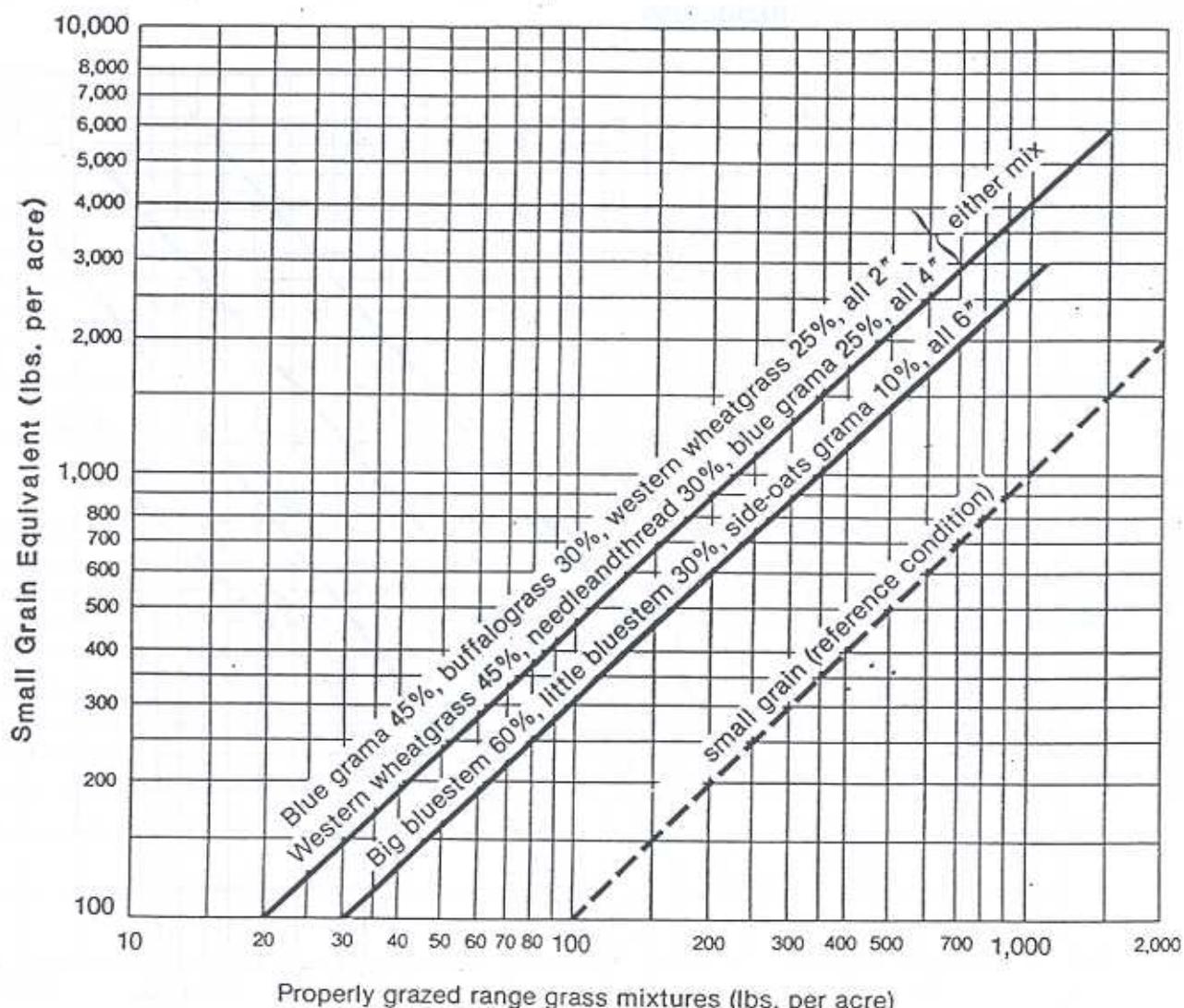
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980 Journal Range Management, 33(2), pages 143-146.

Chart 4(25)

1985

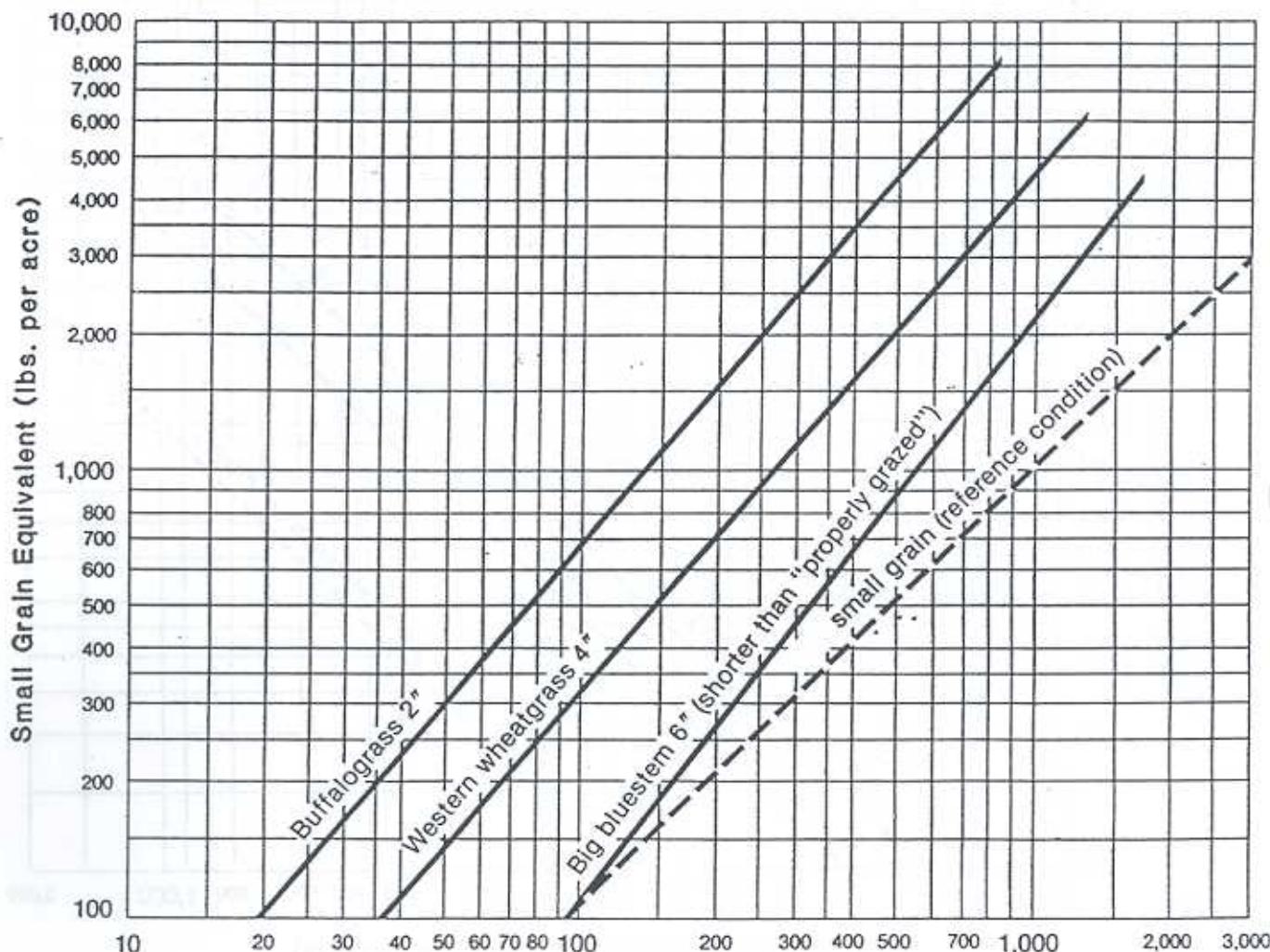
Small Grain Equivalents of Properly Grazed Range Grass Mixture



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980 Journal Range Management, 33(2), pages 143-146.

**Small Grain Equivalents of Properly Grazed Big Bluestem,
Western Wheatgrass, and Buffalograss**



Properly grazed big bluestem, western wheatgrass, buffalograss (lbs. per acre)

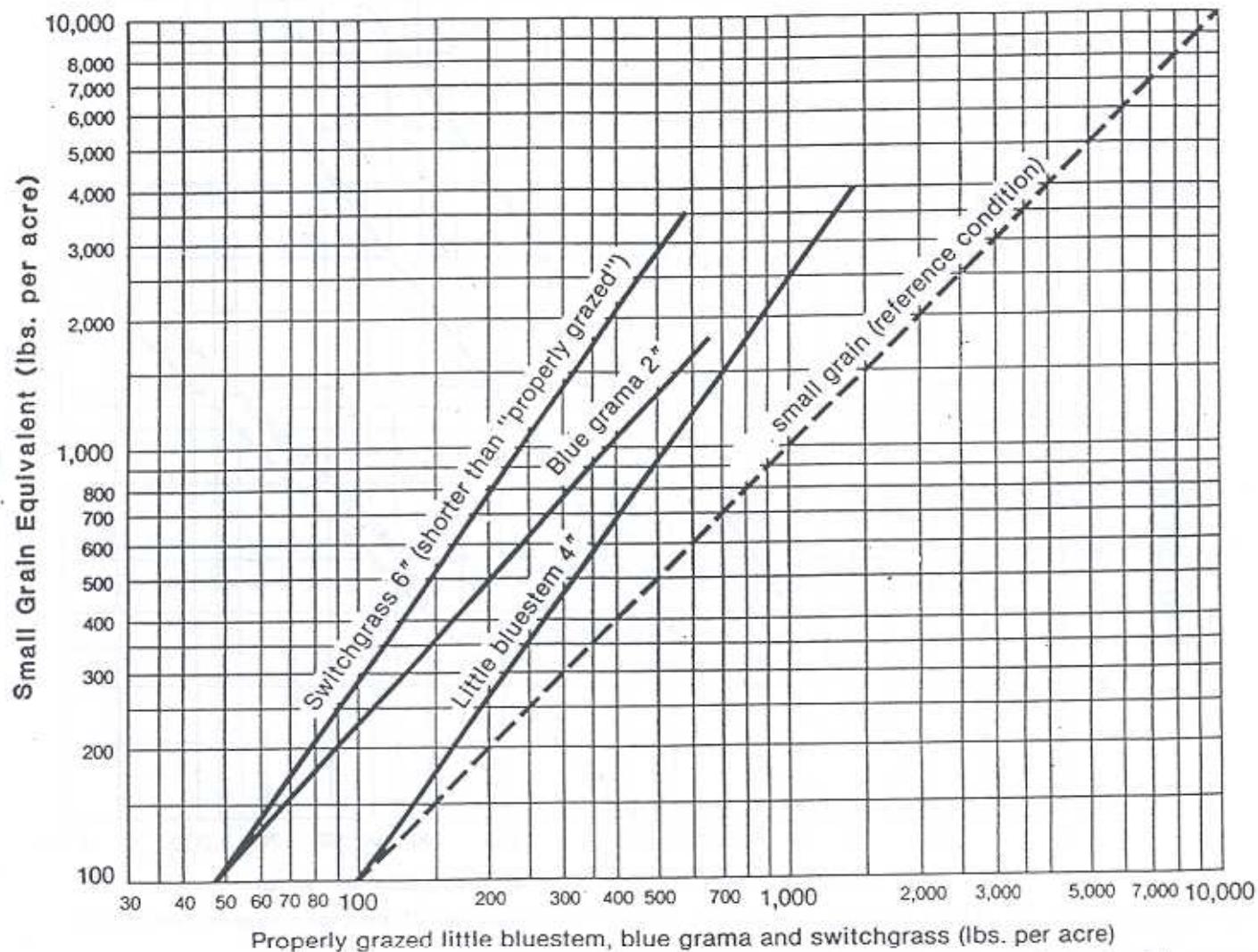
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980, Journal Range Management 33(2), pages 143 - 146.

Chart 4(27)

1985

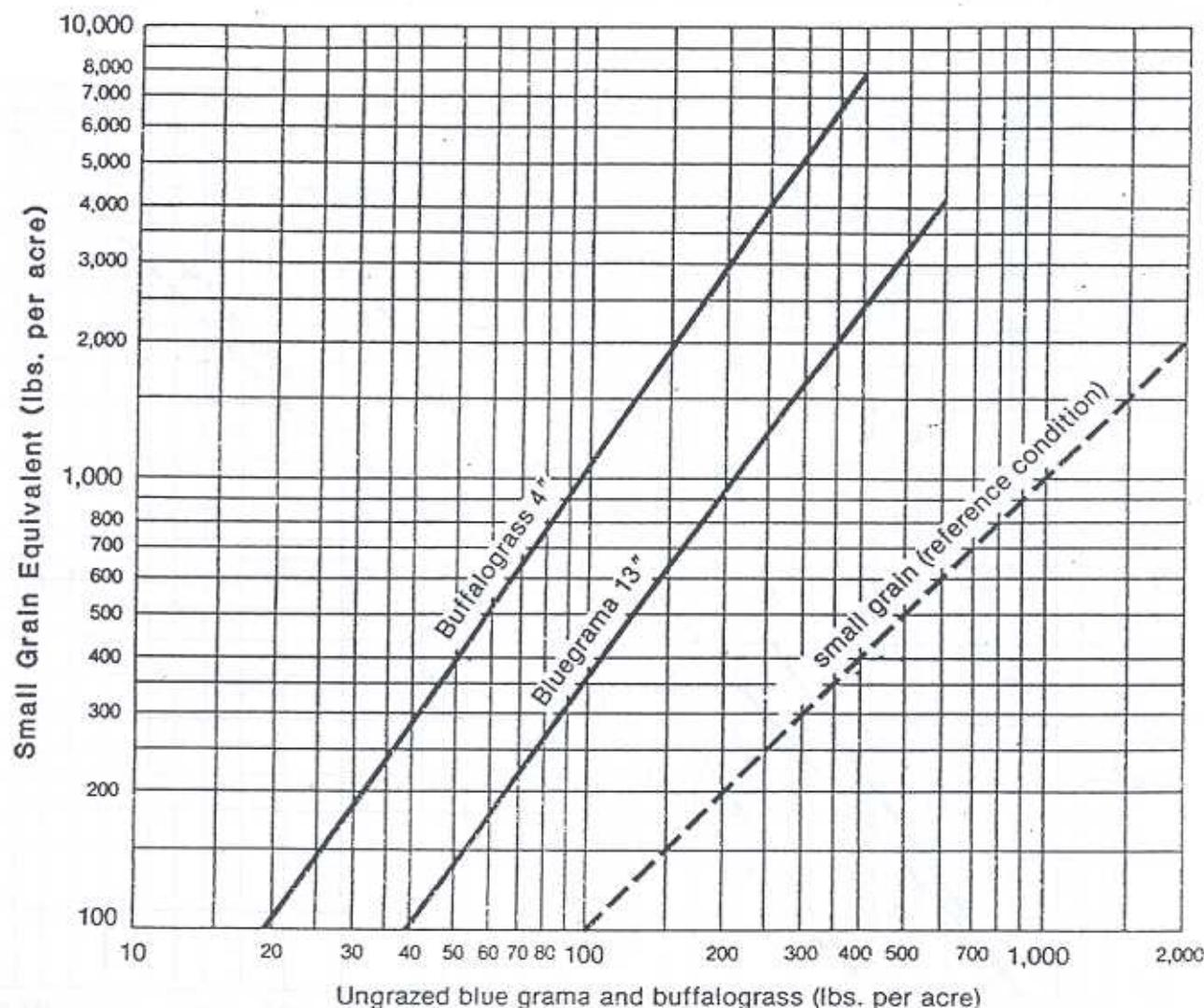
Small Grain Equivalents of Properly Grazed Little Bluestem, Blue Grama, and Switchgrass



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980, Journal Range Management 33(2), pages 143-146.

Small Grain Equivalents of Ungrazed Blue Grama and Buffalograss



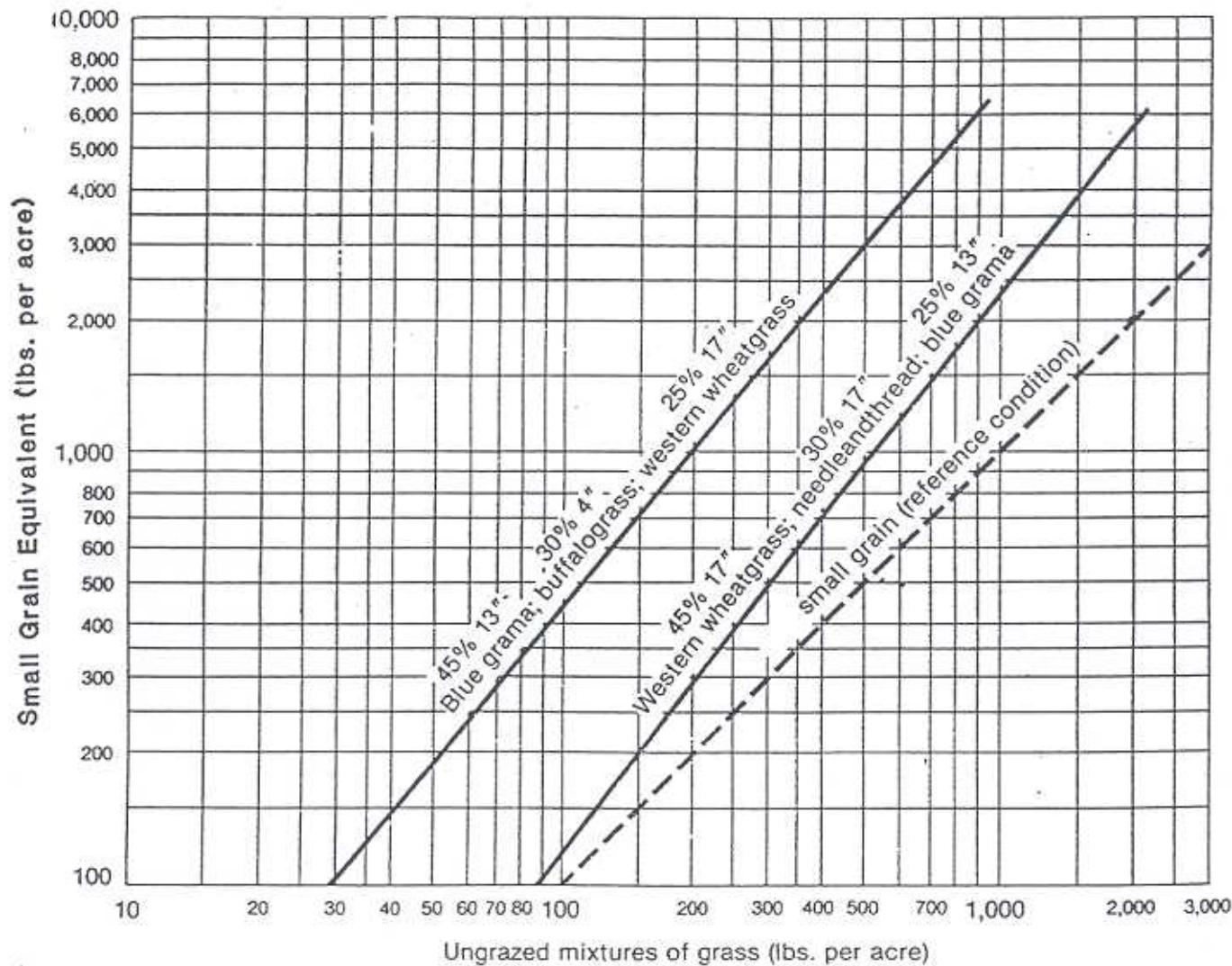
Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980, Journal Range Management 33(2), pages 143 - 146.

Chart 4(29)

1985

Small Grain Equivalents of Ungrazed Western Wheat, Needleandthread, Blue Grama, and Buffalograss Mixtures



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction.

Source: Lyles and Allison - 1980, Journal Range Management 33(2), pages 143-146.